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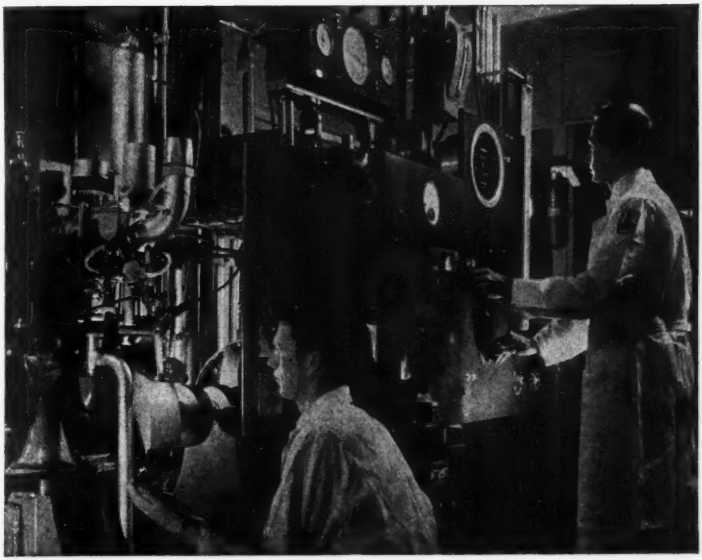

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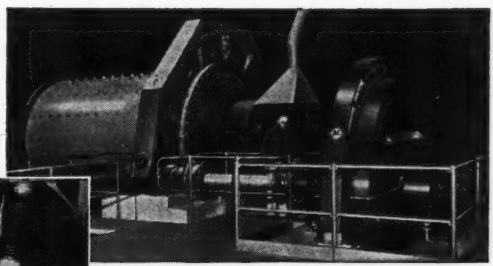

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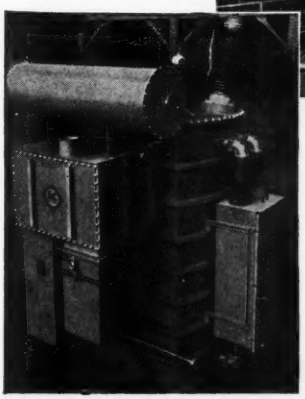

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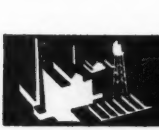

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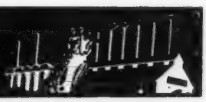
from McGRAW-HILL 

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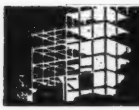

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The Professional Engineer—

Ascending to New Heights or Leveling Off to Mediocrity?

By W. R. WOOLRICH

President of the American Society for Engineering Education and Dean of Engineering, University of Texas

For more than four decades the Founder and associated engineering societies have been making some effort to bring together all of the professional engineers of the United States as a unified group. Their problem is not unlike that which faced the Continental Congress when that body labored with the task of bringing together the people of thirteen states each with a high premium on their political freedom.

The first organizational attempt to unify the engineering professions was initiated in 1920 by the Founder societies when a Federation of American Engineering Societies was formed with the American Engineering Council as its operational staff. By 1924 this organization structure was changed and then evolved the American Engineering Council as a single unifying agency.

The early activity and progress of the American Engineering Council was effective from its point of vantage in Washington, D. C. but its financial structure was not one that could withstand the vicissitudes of a sustained depression. Dissention about both the function and financial support of this Council led to its complete abandonment by 1938, another depression fatality.

Growth of ECPD, NSPE, EJC

While the American Engineering Council was experiencing a loss of national society moral and financial support, there was organized in 1932 the Engineers' Council for Professional Development dedicated to promote the professional growth and status of engineers and potential candidates of engineering from the period of pre-college preparation thence through college and pre-registration to final recognition as a member of the profession.

During this same period of the rise of the ECPD, an active segment of the professional engineers registered in the several states founded the National Society of Professional Engineers in 1934 and established headquarters in Washington, D. C. Full membership in this organization was limited to those who were recognized by state registration as professional engineers. Many of the services performed by the American Engineering Council for the engineering profession at the national capital were taken up by the NSPE as the ACE closed its doors in 1938.

In 1941, the several Boards of Directors of the Founder Societies created a Joint Conference Committee made up primarily of their retiring Presidents and Executive Secretaries. This group after four years of deliberations established, with the approval of their respective Boards, the Engineers' Joint Council.

It was this Council together with the National Society of Professional Engineers that in July, 1952, secured the Congressional recognition of engineering as a profession in a directive which Congress gave to the Salary Stabilization Board of the United States. This statute exempted professional engineers employed in a professional capacity from further wage and salary controls on the same basis as members of the medical and legal professions.

Unionization of Engineering

This recognition immediately brought forth a stepped-up activity of the independent bargaining engineering unions. Any permanent legislation by Congress which would recognize engineering as a profession would curtail the field of activity of engineering collective bargaining agencies.

Their published reports show that on December 31, 1952, the independent bargaining groups of engineering employees as independent unions were activated as The Engineers and Scientists of America (ESA). It was their hope that by the time of their first annual meeting in Los Angeles in February of 1953, the forty thousand members of the local groups would unite into one national organization, the ESA. The interim President, Mr. Joseph Amann, announced: "Representatives of Engineers and Scientists of America are prepared to meet other labor leaders and Senator Taft to discuss amendments to the Taft-Hartley Act, provided a meeting can be arranged. Engineers and Scientists of America is the only national organization whose members engage in collective bargaining with their employers to speak for the approximately 400,000 employed non-supervisory professional engineers and scientists who are so vital to our national defense and to our way of life."

The Vice-President of the newly formed ESA, Mr. John Taft, at an open meeting at Summit, N. J., November 19, 1952, outlined the activities through which they expect to carry on their promotion. The first activity mentioned was announced as "Representation of engineering and scientific employees before government bodies, colleges, political groups, etc. for the purpose of 'setting things straight' with regard to engineer's views on matters of interest to them."

Following his formal talk at Summit, Mr. Taft stated: "ESA expects to conduct an 'Industry Evaluation' program in which it will study the working conditions, salaries, fringe benefits, etc. of various large firms. The result of the study will be made available to college students as well as to the engineering and the scientific profession for their information and guidance." He further revealed that ESA plans to organize student chapters at major engineering colleges and defended this plan by stating that professional societies have student chapters and that his organization is entitled to the same prerogative.

The previous surveys of the National Societies Committee prepared in May, 1946 indicated that as of that date less than five per cent of the engineers questioned favored a certified union. Those who opposed the union of engineers did so usually on the basis that by unionizing:

1. Individual initiative would be restricted.
2. Individuals would be regimented by the union organization.
3. A "typing" of engineering positions and a "leveling" of salaries would result.
4. Professional status and prestige of engineers would be damaged if not lost entirely.
5. Individual advancement and recognition of individual achievements would be stifled.

Probably our democratic process of our unifying engineering councils has been too slow to keep pace with the rapid strides made by the engineering profession. The Engineers' Joint Council, the Engineers' Council for Professional Development and the National Society of Professional Engineers now face the alternative of speeding up their coordinated effort to improve the professional status of the recognized engineer or giving way to a less discriminating group of union engineers who would like to speak for all of us on the workman's side of the collective bargaining conference table.

Responsibility of American Industry

American industry has also much at stake in this situation and much of the corrective work in our present salary scales must come from the employers of engineers. There is little about which to

quarrel by the engineering profession as related to beginning salaries for men with Bachelor's, Master's or Ph. D. degrees in engineering, but the scales of advancement have been woefully neglected by a large portion of American industry. If management would do its part, the spread in salaries for professional engineers must be greatly increased for men of three, five, ten or twenty years of service commensurate with the beginning salaries if the engineering unions are to be effectively answered.

The engineers of less than average ability can generally be given a salary lift by a collective bargaining agreement. In the leveling off process he gains at the expense of those who are above the average. When a union is first established there may be even a higher average wage than could have been obtained by individual contract by superior engineers. But the future is not too bright in collective bargaining for the advancement of men of creative genius and individual professional abilities. Collective bargaining is never inspirational to the man of creative talents and recognition cannot be readily afforded him other than as part of a collective group.

Role of the Engineering Societies

In this emergency may we look to the Engineers' Joint Council, the National Society of Professional Engineers and the Engineers' Council for Professional Development to effect a program for the elevation of the professional engineer to new heights of accomplishment. We urge that American industry follow the leadership of some of the associated member companies of the American Society for Engineering Education and revise their salary scales for the advancement and recognition of engineers to levels commensurate with their professional contributions.

More recently, the Engineers' Joint Council has greatly broadened its base of membership to offer participation by a selected group of additional professional engineering societies. The American Society for Engineering Education has accepted membership within this Council. Past President Thorndike Saville is the appointed representative of the American Society for Engineering Education and in the reorganization of EJC at the session of January 24, Dean Saville was named its Vice-Chairman. He is our spokesman in this expanded program.

The future of engineering as a profession in North America depends upon the ability of the engineering colleges to advance their education to new levels of professional achievement. The incentive for both students of engineering and the engineering colleges, however, is in the hands of those who direct the progress of the graduates after they leave the college halls.

The answer to either the students of the engineering colleges or to the man who plans to grow is not unionism. The reward for which the professional engineer strives is a composite of full recognition and appreciation for the manpower product of the engineering colleges by those who employ, advise and direct. The compensation should be commensurate with the abilities and contributions of each individual of the profession. It is essential that the salaries for men of accomplishment and years of service shall be an incentive to the men entering the profession.

We need, now, positive constructive action in this emergency by our constituted leadership of the engineering profession. The evolving Constitution of our unity organization does not authorize autocratic action so essential in emergencies to the preservation of our national government but we must face this problem of *unionism* vs. *full recognition as professional engineers* before the eyes of all Americans with decisiveness and constructive action. It will require an all-togetherness and unanimity of purposefulness to meet the rising trend to legalized mediocrity through collective bargaining. If we, as professional engineers, are as effective in applying the principles of management as we boast, then our unity organization can find the answer without our turning to dictatorial government agencies for a solution.

Do You Know That—

► The program for the Annual Meeting —University of Florida, June 22–26— strongly emphasizes the influence which the rapid advances in science and technology are exerting upon engineering education. The Councils, Divisions, and Committees have diligently planned conferences and General Sessions to bring to the membership some of the nation's foremost authorities on the vital problems affecting engineering education. We are anxious to tell you all about it, but it would take half of this issue of the *Journal*. So here's a once-over-lightly synopsis of some one hundred and fifty papers which will appear on the program.

► A challenging General Session featuring nationally eminent speakers on "Encouragement of Fundamental Research as an Aid to Education in Engineering" has been arranged by the Research Council for Wednesday morning. The ECRC program will also include a conference on research developments in the South, and another on the ever knotty problems of Contract Relations with the Government, in addition to its traditional Banquet on Tuesday evening.

► Our Administrative Council (ECAC) is planning a timely General Session dealing with relationships between education and the engineering profession. This will also include some interesting developments in the articulation of high school and college studies, a current problem being developed by the Committee on Secondary Schools.

► Invitations to attend the Annual Meeting are being extended to engineering colleges throughout the world (except for Malenkov's proletariat). In addition to the International Night Dinner, which has become a distinctive event at the Annual Meeting, the International Relations Committee of ECAC is planning a conference program, featuring a number of speakers who are shaping the government's program of technical assistance to foreign countries.

► Mathematicians and engineers alike will be interested in the two conferences on "Programing for Electronic Digital Computers" by Dr. J. H. Curtiss, Chief of the National Applied Mathematics Laboratories of the Bureau of Standards. This is an unusual opportunity to enlarge upon our knowledge of this development which is revolutionizing higher mathematics and engineering. Several of the other mathematics conference papers have the intriguing titles "Let the Pythagoras Do It" and "The Mental Constructs of Science."

► A repeat on last year's successful conferences on atomic energy will be staged again this year, with outstanding atomic energy authorities.

► Here is a unique opportunity to organize a prospecting party and make your trip profitable! Mineral Engineering is scheduling a paper on "Oil Possibilities in the Southeast," by a noted Florida state geologist who should know. We hope that he'll drop a few hot tips.

► Engineers and economists will be interested in the outstanding program of the Engineering Economy Division, featuring a number of prominent economists from industry.

► Civil Engineering, as usual, has come through with an outstanding and varied program. One conference will deal with "The Place of the Doctor's degree in Civil Engineering," another with "Transportation Engineering," and still others on

"The Integration of Graduate Work by Means of Analogues." The Fluid Mechanics advocates will have their conferences dealing with Instrumentation, Sanitary Engineering, and Hydraulics. Also, there is an interesting conference entitled "Professional Skills as Tools in Developing Initiative and Originality," sponsored jointly by the Civil Engineering and Educational Methods Divisions. The Civil Engineering and Architectural Divisions are scheduling a conference on the Training of Engineers for the Construction Industry.

► Chemical Engineering will feature the teaching of instrumentation in Chemical Engineering, with a distinguished panel of speakers.

► The Electrical Engineering Division is planning a unique series of open-forum discussions relating to various areas of electrical engineering instruction, designed to identify some of the more acute problems in this field and discuss new trends and subject matter integration.

► The Educational Methods Division is doing an active and very effective job in intra-curricular coordination, as well as in investigating vital areas of teaching improvement. This is reflected in unusual conference titles such as "Developing Originality in Terms of New Tools of Engineering," "Educational Research," "Subject Matter Integration," "Professional Skills as Tools in Developing Initiative and Originality."

► Engineering Mechanics has several unusual conferences devoted to "Objectives in Advance Design," "Presentation of Undergraduate Mechanics" and a luncheon talk on Engineering Leadership.

► Engineering Drawing can always be counted on for stimulating and educational programs and this year's conferences on widely varying subjects will be of vital interest and a real challenge to drawing teachers.

► In addition to several joint conferences with the Divisions of Engineering Drawing and Civil Engineering, the Architectural Engineering Division is planning a discussion centered around "Architectural Engineering Curricula" at various universities.

► The energetic and rapidly growing Relations with Industry Division has top-flight conferences centered around the themes "The Impact of Recent Industrial Trends on the Engineering Profession," "Education-Industry Cooperation for Promoting Pre-College Preparation," and "Education-Industry Cooperation on Faculty Employment in Industry." These conferences will be of great interest to our members from industry, as well as to educators.

► The Humanistic-Social Division and English Division have formulated interesting programs dealing with "The Challenge of the Creative," "Meeting the Practical Problems," "New Directions in the Humanistic-Social Program," and one with the provocative title "How Can the Humanistic-Social Studies Contribute to the Professional Development of the Engineer?"

► For a refresher, try this one of the Evening Engineering and Graduate Studies Divisions—"Graduate School Traditions, Are They Adequate For Expanding Nation-Wide Programs in Graduate Engineering Education?" We hope that they get an answer to this vexing problem which confronts many engineering colleges.

► The Graduate Studies Division also has a conference program on "The National Science Foundation and its Relation to Engineering Colleges."

► Industrial Engineering is featuring conferences on "Quantative Measures in Industrial Engineering," "Industrial Engineering Practices in Industry" and "Materials Handling."

► A distinctive feature started last year was a conference by the Engineering Li-

braries Committee which has been widely acclaimed by technical journals throughout the country. This year's conference will again deal with engineering literature and its importance in engineering education.

► All young engineering teachers will want to attend the eventful and imaginative program consisting of three conferences, a luncheon, and a dinner, arranged by the ASEE Committee on Young Engineering Teachers. The prize winning papers for the Young Engineering Teachers' Contest will be presented on Tuesday afternoon, along with several papers, one having the intriguing title, "The Young Engineering Teacher—His Responsibilities and Frustrations." Another of their conference papers is entitled, "The Second Look—Or a Double Take" and still another has a live demonstration entitled "Reflections" by an anonymous performer.

► Technical Institute teachers are assured of an exceptionally informative program dealing with some of their more acute problems in the conferences dealing with "Technical Institute Relations with the Public," "The Role of Technical Institute Education in the Years Ahead," and numerous other highly pertinent subjects.

► The Cooperative Education Division will hold a clinic to dissect current problems in cooperative education, as well as a conference on Observations of the Cooperative System of Education.

► Crystal-gazing is the distinctive feature of the Aeronautical Division in its unusual conference "The Aeronautical Curriculum of Tomorrow."

► Mechanical Engineering offers an interesting and varied program including a conference on "What is Our Job in Heat Power-Education or Research?" One of the papers has the alluring title "So You Want to be Promoted." Interesting programs are also planned by the Machine Design and Manufacturing Processes Committee and the Division will have a dinner to top off the program.

► The General Session on Tuesday morning will feature talks by Dr. Hillis Miller, President of the University of Florida, and our own President Woolrich, as well as another speaker of national prominence. A unique feature this year will be a General Session on Monday afternoon, at which time there will be an open-forum discussion on some of the principal projects of the Society, including the work of the Committees on Evaluation of Engineering Education, Teaching Aids, Promotion of Ethical Standards, and Engineering Manpower. This will provide an opportunity for the membership to express their ideas on some of the principal Society projects.

► The Banquet will again be on Thursday evening, at which time there will be a noted speaker and the Lamme and George Westinghouse Awards will be presented to recipients. A new feature this year will be the presentation of two awards for the prize-winning papers by young engineering teachers—an innovation which has proven exceedingly popular with the younger members of the Society.

► The University of Florida Local Committee has done a superb job in planning general entertainment for Wednesday evening and an irresistible program for the ladies, including visits to many of the entrancing vacation attractions of Florida, and even sitter service and entertainment for the kiddies.

► Here is an unusual opportunity to expand your outlook on engineering education, enhance your professional values, make new and stimulating contacts, and to combine all of this with a good time. Why not mark it on your calendar now —June 22–26, University of Florida.

► See you in Florida.

ARTHUR BRONWELL
Secretary

The University of Florida

For many who come to Florida in June, 1953 to attend the Annual Meeting of the American Society of Engineering Education it will mean revisiting a State where they have found many delightful days of vacationing at other times. It likewise will mean a surprising satisfaction to all to find a spirit of economic importance, developed out of industrial and agricultural growth.

The University of Florida takes pride in the knowledge that it has made and continues to make valuable contributions to that growth.

The University is happy that the American Society of Engineering Education has seen fit to hold its Sixty-First Annual Meeting in connection with the Centennial Celebration of its founding.

The beginnings of the University go back one hundred years, back to days when its first College of Arts and Sciences opened in 1853. With the passage of the Morrill Act, the College of Agriculture, College of Engineering, and the Agricultural Experiment Station came into being.

It is a matter of special interest to educators that as far back as 1905, the State Legislature wisely abolished the then existing six State Colleges and provided for two new institutions of which the University of Florida is one. This Act of the Legislature provided for a Board of Control composed of seven members representing the seven geographical sections of the State, all serving without compensation except for travel and incidental expenses, and gave to this Board supervision over the two newly created institutions.

This simplified program of operation of the two institutions of higher learning has meant much to the State and to the University. Some years ago a move made by the University was the adoption of lower and upper division categories for undergraduate education. Under this program the student is given basic comprehensive courses and essential background courses for the specialized fields during the first two years. The junior and senior years are devoted to studies in the several specialized colleges.

There has been the closest cooperation among the lower and upper divisions, resulting in a smoothly functioning program and enabling the student to qualify fully and promptly for his chosen specialized field.

The home of the University of Florida is Gainesville, a city of not more than 30,000 in population situated in the rolling highlands of Central Florida about midway between the Atlantic Ocean and the Gulf of Mexico. Extremes of heat are unknown and frost rarely occurs, and these favorable conditions, together with relatively slight variations in humidity, insure an equable climate ideally suited for study, recreation and rehabilitation.

While the State of Florida is often thought of as a winter resort and playground, the citizens of the State, many years ago, realized the need of developing the many natural resources found here and thus began the move of industry into the State keeping step with the rapid development of agriculture and cattle raising.

The College of Engineering of the University was quick to appreciate the need for trained engineers to meet the rapidly growing requirements of industry. Since the early forties the entire staff of the College has grown from 24 to one of 240 inclusive of the personnel assigned to the Engineering and Industrial Experiment Station. During that same period, the research work done in the College has proved of highest importance to the Defense Program of our country. Much of

this work is still top secret but it can be told that the contribution made to the development of the VT proximity fuze and the work on storm location, later called sferics, earned national and international recognition for the College.

Early in 1951 the first wing of the new building designed to house the College of Engineering was dedicated. In it are now housed the administrative offices, the engineering sciences library and some of the facilities required by the Electrical, Mechanical, Industrial and Civil Engineering Departments consisting of offices, class rooms and laboratories. When entirely completed, the building will have a floor space of more than 250,000 square feet.

The Engineering and Industrial Experiment Station came into actual being in 1941 as an integral part of the College of Engineering. By this act, the State Legislature gave clear recognition to the fact that a program of research is essential as a complement of a great educational program and established the College of Engineering in the upper bracket of outstanding Engineering Colleges in America.

Mention of a partial list of the research projects undertaken by the College will show the spirit of the College in promoting the welfare of the Nation and the development of the resources of the State, such as pulp and paper technology, sewage and waste disposal, fluorine technology, tropical deterioration, ceramics, electronics and weather radar research.

Bachelor's and Master's Degrees are granted in Aeronautical, Agricultural, Chemical, Civil, Electrical, Industrial and Mechanical Engineering. All curricula, except the Agricultural (which is new), are fully accredited by the Engineering Council for Professional Development.

The Doctor's Degree is given in Chemical and Electrical Engineering and the Degree of Professional Engineer is offered in each degree granting department.

Since 1941, there has been a steady increase in the student body of the University which reached a peak of approximately 10,000. The College of Engineering enjoyed a similar increase with a maximum of about 1800. Contrary to the trend which showed a decrease on a national scale as indicated by a Government survey made in 1951, there were twice as many Freshmen engineers at the University of Florida in 1951 as compared to the enrollment of 1941. The current Freshmen engineering registration has increased to about 650 which is about 200% above the 1941 enrollment.

Likewise, the teaching and research staffs have grown. At present the College has a total professional staff numbering 123, of whom there are 27 who have received the Doctorate Degree.

The College budget also has expanded and the combined teaching and station budget is now $1,500,000. The station budget is about $1,000,000 which is twice that of the teaching budget. About $180,000 of this amount is appropriated directly to the station from state funds, the remaining coming from contractural sources.

The College early realized the importance of working with industry and engineers in the field. This is evidenced by the establishment in 1922 of a "short course" for those interested in electric measurements. It is probably one of the oldest University "short course" conferences in the country. Since that time, similar conferences have been held in the fields of Highways, Public Health, Surveying and Mapping, Air-Conditioning, Industrial Instrumentation, Pulp and Paper Technology and other fields of interest.

The State has provided an attractive retirement program for its employees, provided for pleasant working conditions and maximum academic freedom for all.

Proper dissemination of research for the benefit of other workers in the field and for the public in general is of paramount importance. No matter how significant the research results may be, the value of the research may be lost unless the information is put in the hands of those who can use it. Thus, it is the aim of the College to publish all research of

value conducted by the Experiment Station except where national security is involved.

There are three series of Station publications: (1) Bulletin Series—original publications of research, usually on problems of specific interest to the industries of the State of Florida; (2) Technical Paper Series—reprints of technical articles by staff members appearing in national scientific publications; and (3) Leaflet Series—non-technical articles by staff members which have appeared in the more popular periodicals. These papers are published under the title "ENGINEERING PROGRESS at the University of Florida" each month. In addition to a regular subscriber list of 1200, publications are circulated to some 6000 to 7000 individuals each year by special written request.

Since the publication of its first bulletin in 1933, the Station's list of publications reporting results of research completed or in progress has grown to 170. In addition, many restricted reports have been issued to industrial and military sponsors of Station projects.

Thus the College of Engineering, through the Experiment Station, continues to fulfill its purpose of conducting "research in the field of engineering and related sciences with special reference to such of these problems as are important to the development of industries in Florida" and to promote the graduate program in engineering to supply those industries with trained personnel.

Reserve this date . . . .

June 22-26, 1953

ANNUAL MEETING

UNIVERSITY OF FLORIDA

GAINESVILLE, FLORIDA

An Experiment in Conference Teaching

By HERBERT L. MANNING

Head, Department of Industrial Engineering, Virginia Polytechnic Institute

This experiment in the conference method of instruction is the result of discussions with a number of recent graduates of the Industrial Engineering Department at Virginia Polytechnic Institute. In these discussions one outstanding omission has come to light in our curriculum. Returning graduates have stated repeatedly that they are not prepared when they graduate to participate in or to lead group discussions. The conference method is used by industry extensively in the training of the men we graduate and also to train others of their supervisory personnel for management staffs. An analysis of our curriculum discloses the usual situation:

1. The program is already overcrowded.
2. Nothing appeared possible of elimination so that course material could be added to assist the program.
3. All students are required to take a course in "public speaking."
4. The problem would not be solved by more course work of the type usually thought of as "public speaking."
5. One course was available which included conference leadership as a technique of supervisory training.

The next point was to analyze our teaching methods in the department to see whether any changes could be made which would yield the desired results. It was decided to experiment on three courses in which substantial amounts of practice might be obtained by the students in conference participation and conference leadership. These three courses are "Principles of Industrial Organization and Management," "Wage and Salary Administration," and "Industrial Supervision."

In order to accomplish the mission in the management course it had to be redesigned and material of a case study nature accumulated which would illustrate the principles of industrial organization and serve as a basis for discussion. This course is taken by the Industrial Engineering students during the junior year and there was some hesitation in attempting to teach by the case study method at such an early stage. It was felt that one of the major objectives in this program should be the establishment of self confidence in the student's ability to lead and actively participate in group discussions. Therefore, starting the experiment in the junior year gives the students as much practice as possible before their graduation. Accordingly, the work was outlined for the first quarter course so that the instructor led the discussions for about the first four weeks of the quarter. During this time instructions were given in how to analyze case material, how to extract information from it, how to develop the questions worthy of discussion, and by direction and illustration the students were shown how to bring points of discussion before the group and how to control discussion. It has been found that training in these techniques takes away very little time from the subject matter of the course. Starting about the fifth week of the course each student in the class was assigned responsibility for leading one of the discussions of cases which would be considered for the remainder of the quarter. These cases were interspersed with discussions led by the instructor on basic

principles which had to be highlighted in the course content.

Prepared Outline Required

In order to insure proper preparation for the leading of the discussion, the instructor requires that the student turn in his prepared outline of the discussion at the end of the period during which he has led the discussion. In addition to this, the student discussion leader is also required to turn in a short report in which he analyzes what his objectives were in the conference and the manner in which he accomplished these objectives and, most important, things he failed to do to fully attain the objectives he had set forth for discussion. These procedures will carry through into the second quarter of the course and will insure that each student has at least two opportunities to lead the discussion.

In the course in Wage and Salary Administration the instructor again leads the discussion for the first part of the course. The instructor also gives to the student an outline containing the most essential points of the various subdivisions of the subject. Inasmuch as this is only a one quarter course, and inasmuch as it is given in the senior year, student leadership of the discussion starts earlier in the course, usually during the second week of class meetings. During the first week the students select the area of the subject in which they prefer to lead the discussion. In this course no case studies as such are given to the students to serve as a basis for discussion. A list of references, magazine articles, and other periodical material is given to the student and it is up to the discussion leader to bring such current case material into the discussions as he feels desirable to accomplish the objectives of the discussion for the period. This is done deliberately in order to develop in the student a realization of the necessity for obtaining material to illustrate and further the understanding of any group discussion which he may lead. Again, in this course the leader is required to submit an analysis of his objectives and their accomplishment at the termination of his discussion.

In the course in conference leadership, the subject matter for the discussions is industrial personnel problems or matters of local or national interest occurring at the time. The idea is to give the student opportunity and practice to develop material of current interest and to use it in conferences as he might when he gets into industrial employment.

It is perhaps obvious that the above three courses have in their content more material of a subjective nature than many of the courses in other areas of engineering; and the question perhaps arises, can this experience be given to students in the more objective type of course?

Some experimenting has been done and the answer seems to be yes, but to a more limited extent than in the subjective type course. For instance, in such courses as motion and time study, engineering economy, tool engineering, or quality control, it has been found possible to treat the matter somewhat as follows. The instructor develops the essential theory and discusses it with the class in the usual manner. Following the discussion of the theory certain problems are assigned which illustrate the application of the theory. The problems are, of course, then reviewed to insure understanding of the theory and its application. It is in this discussion of the application of the theory in terms of the problem that students assume leadership of the discussion. This has been attempted and found to be an opportunity to give practice to the students in this regard.

Evaluation

It is, of course, impossible at this point to give any factual estimate of the success of this approach. The ultimate test, and of course the only true test, will come when the students who have had this opportunity graduate and get into situations which test the ability which we have been attempting to develop.

It should, of course, be obvious that the success of any program of this type is

dependent upon reasonable class size. It has been found that more than twenty in the class makes such an attempt virtually impossible, with fifteen being the ideal maximum. Individual participation in the discussions seems to vary almost inversely with the number of students in the class group. The only conclusions available so far seem to be that the students who have participated in this type of course presentation seem to be more articulate and seem to have more confidence in their ability to state their opinions. They have definitely improved their ability to stand on their feet and control discussion. Further, the students who have been in the classes where this technique has been tried seem to have developed more interest in the subject and have definitely stated their liking for this type of class presentation.

This idea is not new nor has our experiment resulted in a finished technique. A great many more students must take part in this conference method of instruction; a better cross section of courses must be explored, and an extension of the idea has to be developed in other courses in order to evaluate the real potential of this method.

Electrical Engineering Division Summer School at Dartmouth

The Electrical Engineering Division of the ASEE held a Summer School on "Teaching of Electric Circuits and Fields at the Undergraduate Level" at Dartmouth College on June 20 and 21, 1952. Planned to occupy two days and one evening, the sessions were attended by over 60 electrical engineering teachers. In addition, an informal discussion period developed on the second evening which added materially to the value of the school. At this informal meeting the subjects discussed ranged from special teaching methods to a description of electrical engineering curricula and teaching in Canada as contributed by a Canadian representative.

Friday was devoted to a study of the teaching of electrical circuits and Saturday was given over to a discussion of the teaching of electric and magnetic fields. Single speakers occupied the morning in order to have time to fully cover the assigned area and to permit considerable discussion. The afternoons were given to two speakers in each case, to cover particular assigned areas.

Dr. M. B. Reed, of the University of Illinois, on Friday morning reviewed fundamentals in the teaching of electric circuits, including the necessity for clearly defined notions of polarity and circuit notation. In the afternoon Professor E. M. Strong, of Cornell University, discussed "Use of Loci in Circuit Analysis," and Professor R. M. Wainwright, of the University of Illinois, demonstrated the use of matrices in circuit analysis with particular emphasis on polyphase circuits and symmetrical components.

On Saturday morning Dr. W. B. Boast, of Iowa State College, reviewed the general subject of teaching of "Quasi Static Fields," giving methods applicable to the introduction of the subject at the sophomore level. In the afternoon Dr. G. B. Hoadley, of North Carolina State University, discussed the teaching of dynamic field theory in the senior year, and Dr. J. F. Calvert, of Northwestern University, discussed flux plotting and gave some interesting illustrations of the method.

On Friday evening Dr. A. R. D'heedene, of Bell Telephone Laboratories, discussed certain applications of network theory as employed in circuit design. J. D. Ryder, of the University of Illinois, served as Chairman for the Summer School.

Training Engineers for More Effective Results in Industry*

By MR. ROBERT C. SPRAGUE

President, Sprague Electric Company, North Adams, Mass.

Before beginning to talk about educating engineers, let me state what I think we are trying to educate *toward*. I accept, as not likely to be bettered, Tredgold's definition of engineering as: "The art of directing the great sources of power in nature for the use and convenience of man." This definition excludes the pure scientist. And I am further limiting my thoughts to the engineer who, on completion of a four-year course in one of our 148 accredited engineering schools, contemplates employment in industry.

From the report written by your Committee on Aims and Scope of Engineering Curricula, back in 1940, I infer that, as a group, you also accept Tredgold's definition. I have read that report with the greatest interest and with high appreciation. And I know that the recommendations of that committee have had the direct effect of putting more stress on the humanistic subjects in engineering curricula. That effect is being continually evidenced as more and more schools adopt this broader policy.

My own experience leads me to accept as axiomatic the concept of increased grounding in the humanities for men who must be concerned with such diverse human needs and activities. In our own plant, for instance, one man might apply himself to the components of end-products as diverse as television sets and proximity fuses, radios and guided missiles, or electric razors and atom bombs.

In reading the recent bulletins of a few of the major engineering schools, I have been gratified to see that (largely through the effectiveness of your efforts) considerable importance is now given to such subjects as literature, history, economics and labor relations. And I was particularly pleased to see that several of the more advanced schools, including M.I.T., have adopted the idea that a student should prove his competence in oral and written expression before receiving an engineering degree.

Though I appreciate the progress which has been and is being made in the direction of humanistic study, there is one side of an engineer's education about which I can find very little discussion in the bulletins I have read. This is the training which should increase both his desire and his ability to work effectively with other men.

So much has been said and written about this facet of the engineer's personality that nearly anything I add will be repetitious. But in my own experience I have found a condition so general and so disturbing that I cannot withhold my opinions. I have too often found it exceedingly difficult to get an engineer to work aggressively on any idea suggested by someone else. There is too frequently the N.I.H. (Not Invented Here) factor which prompts him to waste considerable amounts of the company's time and money to prove the superiority of his own ideas. And in his relations with other departments I have found the engineer tends to minimize the opinions of others, especially those of the so-called practical

* Presented at Annual Meeting of A.S.E.E., at Dartmouth, June 1952.

man. By which I mean the man who has acquired sound engineering principles from experience which may have been very extensive, though possibly limited to his company's particular field of activity.

I know you must have heard this comment often from management. I do not know whether your regard it as justified.

Perhaps you agree that this situation does generally exist, yet hold the view expressed by Prof. Drucker in his article in the May-June issue of the *Harvard Business Review*. There, as you probably read, Prof. Drucker takes the position that, both by inclination and training, the professional man is a different creature from the administrative man. Prof. Drucker considers it right that the professional man should be: ". . . trained to work on his own . . ." and that "he does not . . . take kindly to modern organization—and especially not to large scale organization." So, according to Prof. Drucker, Administrative Man must take Professional Man just as he is—and like him. This alone would be disturbing. But I find real cause for alarm in Prof. Drucker's further implication that the ultimate aims of these two groups are mutually exclusive.

May I quote again from Prof. Drucker: "The problem is thus one of basic attitudes. . . . To make matters still more difficult, the attitudes that cause the difficulties are in themselves desirable." And finally I find this opinion expressed by Prof. Drucker: "Professional employees do not fit into the administrative process —and the administrative process does not fit them. In particular, the very concept of 'supervision' goes against the grain of professional employees. In many ways this matter of the 'supervision' of professional employees illustrates the entire problem, for it is a good example of the businessman's failure even to realize that the professional employee presents a problem. 'Supervision'—both the term and the institution itself—is automatically applied to professional employees because it is the established thing for other employees. Yet not only is it resented by professional people; it is not the appropriate organization pattern for them."

Let me assure you that Prof. Drucker is mistaken in his belief that businessmen, as a group, fail to recognize that this problem exists with the professional employee. As I mentioned very early in my talk, I hear that problem often and earnestly discussed both within and outside my own organization. Indeed, these businessmen, because of the very nature of their jobs, are required not only to recognize, but to cope with the problem. Their jobs entail the coordination of individuals into departments, and departments into a unified organization. And so they find it necessary that the parts of a business function smoothly in relation to each other to produce a satisfactory overall result.

In the various phases of design, production and sale of component parts (such as those made in our plant) each member of the engineering staff must have considerable knowledge and constant awareness of the relation of the part on which he is working to other components and to the end-product as a whole. So is it not reasonable to expect him to have similar knowledge and awareness of the functions of other individuals and departments vital to the organization of which he himself is a part?

I hope you do not agree with Prof. Drucker because I feel very strongly that his concept is not merely an unfortunate one, but actually a dangerous one, both for the engineers themselves and for the industry they serve. And I am encouraged to find that my view is validated by at least one of our leading schools. May I read you a statement which I found in the 1952–'53 *Bulletin of the Columbia School of Engineering*?

"The successful engineer must possess to an unusual degree two basic characteristics. First, he must have a capacity for teamwork, an ability to work effectively with others on a common problem in an organized group. The keynote of modern re-

search is the concentration of many minds on a single problem. In construction or manufacturing a capacity for and interest in cooperative endeavor is essential also. An ability to work in, organize, or direct an engineering force, and to aid in establishing esprit de corps is an essential to progressive and productive engineering practice."

If, as I hope and believe, many of you will support that statement, then how shall we approach the problem of correcting, or at least alleviating the situation?

Is it to be expected that the new emphasis on the humanities will improve the engineer's attitude toward his co-workers? Or will the problem have to be more directly approached?

Whatever you answer to this, I am convinced that the observations and experience of industry could be advantageously utilized in the education of young engineers.

So I urge that industrialists be allowed to participate actively in your program for the better integration of the engineer in the company for which he will be working and in society as a whole. For, as an employer interested in training the engineer for more effective results in industry, I do not want him only to be more effective in my own organization. I am interested in showing him the fuller rewards which might be his if he would regard himself, not merely as the *first* citizen of the laboratory, but as *first, a* citizen of the world.

There is one other facet of the subject on which my experience as an employer may qualify me to speak. This is the delicate balance of emphasis on the basic and applied sciences as against applied engineering in a four-year curriculum.

It is estimated that at least 65% to 70% of the engineers who graduated in 1949 and '50 accepted industrial employment. (This specifically excludes federal and state government employment.) Am I correct in interpreting this to mean that, in effect, engineers are being educated today primarily for industry? And if so, does this not add considerable weight to industry's opinion as to the placement on this emphasis in the present curricula?

Stress Basic Sciences

As an employer of more than 100 graduate engineers, I am among those who hold that the education of tomorrow's engineer should stress the basic sciences, even if this can only be done at the expense of applied engineering subjects.

From my own observation I find dramatic evidence that the man with the strongest basic training has the greatest adaptability. Because the basic sciences can be applied to different problems in many branches; or to a single problem which may extend into overlapping branches. In the rapidly changing technological industries such a man enjoys a tremendous advantage.

In our own plant this kind of flexibility, resulting largely from basic training, is conspicuous. One of our most capable men in the electrical field has a chemical engineering degree; and one of our top chemists holds a degree in electrical engineering.

I am of the opinion that this adaptability is important to industry even when there is no dearth of engineers. But when the shortage is as acute as it is now, the man with adaptability unquestionably commands a high premium.

Dr. Preston Robinson, our Vice President in Charge of Engineering, holds the view that good training in the basic sciences qualifies the student for mastery of all branches of engineering and that these principles should be stressed because they are least susceptible to change. He feels strongly that the four-year engineering course should be a broad, professional training; and that specialization should come only from advanced university work, or from practical experience.

If this view were accepted by the engineering schools, the student should be made to understand from the beginning of his course that a high degree of specialization in four years is not desirable; and that it is assumed, both by the school and

by industry, that a four-year diploma will mark only the commencement of his engineering education.

I suggest that industry's attitude is clearly shown by the fact of its encouraging and underwriting of employee-participation in extensive programs for post-graduate study. Such programs, inaugurated by a considerable segment of industry which employs graduate-engineers, are being carried out partly in classes conducted within the employing organization, and partly by attendance at nearby engineering schools.

Graduate study at established schools is being encouraged in two ways: by granting time off for the purpose; and by payment of part of the tuition costs. Let me cite only a few examples.

Because of its far-flung organization, Westinghouse (which was a pioneer in the field of education for professional personnel) has developed a program for cooperation with nine institutions. These are:

University of Pittsburgh
New York University
Polytechnic Institute of Brooklyn
Stevens Institute of Technology
University of Pennsylvania
The Johns Hopkins University
University of Buffalo
Case Institute of Technology
and
University of Delaware

With the result that since 1927 6000 Westinghouse engineers have taken advanced courses at these institutions. And in most cases half the tuition has been paid by Westinghouse on completion of the courses. Of these 6000 students, 200 have earned advanced degrees—including 20 doctorates.

At Bell Laboratories engineers are given five hours' absence a week (without salary deduction) for the purpose of advanced study. Under this plan 96 Masters and 15 Doctorates have been earned by men employed full-time at Bell Labs.

The list of firms cooperating in this way with engineering schools comprises a sort of Blue Book of the industry. To give some idea of its length, I point to the city of Milwaukee where as many as 50 firms are sending engineers to the University of Wisconsin Extension School. I am told that it is usual at Wisconsin for two-thirds of the tuition to be paid by the employing companies: one-third at the time of enrollment and one-third on completion of the course.

The most recent figures I have seen from the University of Pittsburgh were for the year 1948–'49. At that time there were 614 engineers enrolled there from six different industrial firms which paid half the tuition on completion of advanced courses.

Work Closely with Schools

In our own plant, Dr. Robinson and other heads of engineering departments are eager to work more closely with the schools. Up to now we have employed undergraduates in summer; we have sent graduate engineers to the M.I.T laboratories for advanced research work; and two of our men have been given leave of absence for graduate work at M.I.T. We also allow up to three hours per week with no loss in pay for study at nearby Williams College and pay all tuition charges for approved courses there, at R.P.I. and at Extension Schools, one-half on enrollment and one-half upon satisfactory completion of course.

Presumably even more of such encouragement and help might be given by industry to its engineers, but for the fact that many centers of engineering activity are still without facilities for advanced study after work-hours. This possibility has been suggested by a brochure: "The First Five Years of Professional Development" issued by the Engineers' Council for Professional Development. In this I found a list of 50 industrial centers, only 24 of which offer facilities for graduate engineering study in the evening.

In many of these locations where no evening courses are offered, there are already accredited schools for engineering degrees. I suggest that some of them

(such as Brown, Yale, University of Cincinnati, University of Akron and Washington University) be approached with the possibility of offering graduate courses in the evening. While at the same time industry in these centers should be informed of the possibility that new advantages may be offered, and urged to subsidize advanced training for their engineers.

Even this cursory review of the widespread program of industry to foster graduate training might be construed to indicate that industry collectively does not regard the four-year engineering graduate as a very highly developed specialist. The program certainly means that, in effect, industry is giving much attention to, and assuming considerable responsibility for, developing the sort of specialists it needs. So is it not realistic to suggest that the schools throw more of the post-graduate burden on industry and place their emphasis on basic training? This would qualify the graduate to specialize in the direction of those talents which are later found best adapted to the shifting requirements of industry.

Conclusion

In conclusion, I should like to summarize.

My personal observation leads me to place particular importance on three aspects of a four-year curriculum if a primary objective is to make the engineer more effective in industry:

1. The continued increase of humanistic subjects, with sufficient emphasis on economics and business organization to heighten his appreciation of the vital functions performed by all departments in any successful industrial enterprise.
2. Direct or indirect exercise in teamwork—beginning with the members of his own squad or department, and then extending beyond the limits of his organization into his community.
3. More intensive training in the basic and applied sciences—even at the expense of high specialization in the applied engineering subjects.

From the March issue of *The Journal of Engineering Education* I see that a new committee is being formed, under the chairmanship of Dr. Grinter, to make an "Evaluation of Engineering Education." I hope that this will not be an all-academic group. Because I am convinced that our common purpose can best be served by taking a stereoscopic picture from the view-points of both the educator and the industrialist—which points are, I contend, only a short distance apart.

In closing, I again emphatically reject Prof. Drucker's dark opinion of the irreconcilable variance between the professional and the managerial attitudes. But if he is right and I am wrong, may it not then be argued that attitudes are the concern of both school and industry?

Might not your new committee (I should prefer to call it *our* new committee) take time to study the relation of curricula to attitudes? And should we not, *together*, measure and weigh the equipment and attitudes of the young engineer against the requirements and attitudes of industry? I hold it *likely* that we should find these attitudes far from irreconcilable. And I hold it *certain* that, merely by recognizing the problem as our joint responsibility and approaching it together, we shall have taken an important step toward its solution.

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College Notes

Dean Andrey A. Potter of the **Purdue University** Schools of Engineering will retire from his duties next June 30 and will be succeeded by Dr. George A. Hawkins, Professor of Thermodynamics and Associate Director of the Engineering Experiment Station. The retirement of Dean Potter will bring to a close a career lasting 50 years which has placed him among the nation's top engineering educators and brought Purdue to new heights as a center for engineering education in the U. S.

Dean Potter was born in Europe and came to the U. S. at the age of 15. In 1903 he was graduated from the Massachusetts Institute of Technology with the Bachelor of Science degree. He has received honorary degrees from Kansas State College, Northeastern University, Norwich University, Alfred University, Rose Polytechnic Institute and the South Dakota School of Mines. Dean Potter was employed by the General Electric Company from 1903 to 1905 when he joined the teaching staff of Kansas State College as an assistant professor of mechanical engineering. In 1913 he became Dean of Engineering and Director of the Engineering Experiment Station. He came to Purdue in 1920 in the same capacity.

Dean Potter is author of a number of books on power engineering, thermodynamics, and farm motors, and of more than 300 engineering, educational, and scientific papers and articles. He has held many positions of trust in the United States government, including that of Chairman of the Advisory Committee for the Engineering, Science and Management Defense Training Program, 1940–1946, and executive director of the National Patent Planning Commission, and recently was confirmed by the U. S. Senate for a six-year term as a director of the National Science Foundation. His professional honors are too numerous to include here. He is a Past President of the ASEE and received the Lamme Award from the Society in 1940.

Education for Educators*

By ALI BULENT CAMBEL

Assistant Professor of Mechanical Engineering, State University of Iowa

There is considerable evidence that not all those concerned with engineering education are satisfied with it. Industry is not happy with the product it hires. Graduates are not happy with the training they have received. Americans as a whole are complaining that their children are not being properly educated and that they are not developing into productive citizens. Above all teachers of engineering are not convinced that they are doing their best job. Paradoxically, this dissatisfaction should make everyone concerned very happy, because as long as engineering educators are aware of their responsibilities, rather than being smug and self-satisfied, things are bound to improve.

Engineers, during the past few years, have made a definite effort to improve engineering education. A very notable contribution is the report of the ASEE Committee on Improvement of Teaching (1). The problem as clearly presented in this report is a difficult one to tackle. There is no school or institution where one may study the teaching of engineering. There are numerous courses in education. One can actually prepare for a career in elementary or high school teaching, but it is impossible for those desiring to teach engineering to train themselves for the job. Moreover, learning to be an engineer requires so much time that it is almost impossible for a budding teacher to enroll in formal courses in pedagogy in which he could learn the fundamentals of teaching. Therefore, improvement of engineering teaching must be undertaken after one has assumed a teaching position. In a way it is typical "on the job training" and many avenues are open to better teaching. One particular approach to the improvement of teaching has been instituted in the College of Engineering of the State University of Iowa (2).

The ground work for the course was laid by a local committee consisting of one assistant professor from each department of the college. This committee met for several months prior to the inauguration of the course and continued meeting during its progress.

The initial work consisted of defining the objectives of teacher training and of finding the means by which these could best be achieved. After debating numerous possibilities, the committee agreed to conduct a course which would combine the techniques and philosophy of engineering instruction. The committee then held discussions with the dean and with the department heads of the College of Engineering, and their opinions were consolidated with the objectives already set forth. As a third step the College of Education was consulted for suitable topics for the projected course.

Organization

The preliminary organization led to the following decisions: that the course be aimed especially at young teaching personnel consisting of assistants, instructors, and assistant professors, but that faculty members of higher ranks be invited to attend the meetings; that the course in its trial period extend over one complete semester, with one meeting every week;

* Presented at the Conference of Young Engineering Teachers, ASEE Annual Meeting, Hanover, New Hampshire, June 26, 1952.

that attendance in the course be purely voluntary; that no remuneration nor reduction in teaching load, because of participation in the course, be requested from the school administration; and that the course consist of formal lectures given by senior members of the College of Education and of discussion periods led by department heads in the College of Engineering.

The lecture topics in the order of their presentation, were as follows:

Introduction
: The need for teacher training; problems faced by the instructor; history of education; great names in teaching and their philosophies; use of teaching aids.

Educational Psychology
: Psychological factors in students; mental ability and its criteria; aptitude and aptitude-testing; the effect of social and economic background on college study.

Reading and Retention
: Problems involved in reading ability; methods of improving reading; the relation between reading and understanding; retention of material read or heard.

Adult Education
: The aims and objectives of adult education; difference between college education and adult education; techniques of adult education.

Examinations
: The purpose and method of preparing examinations; objective and nonobjective examinations; grading; criteria of good examinations.

Aims of Teaching
: Criteria of good teaching; should students be taught to think? Teaching in a divided world; academic freedom.

Administration
: The private institution and the State institutions; statistics pertinent to education; appointments, promotions, and salaries; the educator as a citizen.

Discussion meetings were held periodically during the semester, two department heads serving as discussion leaders in each meeting and answering questions raised by the audience. Among the questions considered were those concerning the relative merits of lecture and discussion methods of instruction in nonlaboratory courses, the amount of assistance the instructor should give with an assignment before the student has undertaken it, the role of home work, the use of the curve and of other standards of grading, and the proper amount of credit on teaching load for laboratory courses.

Although the program at Iowa was voluntary, attendance at the meetings indicated interest. Senior faculty members, however, were rather more interested than were the young instructors. To some extent this may be attributed to the fact that many young staff members often perform dual jobs because many of them teach while they study towards advanced degrees. Thus they have little time to study teaching techniques.

In the sessions no textbook was used and no assignments were made. However, two booklets were suggested and indications are that most staff members acquired them. These are "Effective Teaching" (3) by F. C. Morris and "Instruction Manual" (4) of the Georgia Institute of Technology. Further articles from the *New York Times* such as those by Benjamin Fine and by Gilbert Highet were discussed.

Observations

It might be worth mentioning that the student body reacted favorably to their faculties striving for better teaching. In fact the university student daily ran an editorial in which it commended the engineering faculty and expressed the hope that other colleges might follow suit.

Such a training course is obviously not the only means for the improvement of teaching. In fact no one method is sufficient to develop a great teacher. Development of great teachers can not come from outside stimuli, but must come from

within the budding pedagog. The greatest responsibility lies with the teacher himself and not with anything or anybody else. Nevertheless, training programs, seminars, etc. do contribute greatly and serve as a forum for discussion.

Furthermore, teacher training programs are very advantageous in bringing to the attention of staff members the best and the latest in education. It should be emphasized that the improvement of teaching need not be attempted in general sessions dealing with pedagogy only. Other programs such as the summer schools organized by the various specialized divisions of the ASEE greatly contribute to better teaching and enhance the capabilities of teachers.

The distinguished philosopher-mathematician Alfred North Whitehead (5) points out that a person must be good in everything and excellent in one. It is more difficult for an engineering teacher. He must be good in everything and excellent not in one but in two things. Being good in everything means being educated physically, mentally and morally. Being excellent in two things means that an engineering teacher must be an excellent engineer and must be an excellent teacher. These are requirements with which it is difficult to comply.

In retrospect it may be said that the Iowa program brought faculty members closer to one another through the concern with common problems and the realization of the fact that there is no one or easy road to good teaching.

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College Notes

John F. Gordon, vice president of General Motors and chairman of the board of regents of **General Motors Institute** announced expansion of the Institute comprising a new building of 83,000 square feet to be added to the present structure. The addition will add approximately 40 per cent to classroom, laboratory and general service areas and the over-all expansion plus the remodeling of the present building will be a total structure of modern acceptable standards equipped throughout with the most recent and effective type of engineering educational facilities.

The expansion at General Motors Institute will result in greater emphasis in the curricula on the experimental approach to problems ahead. Wide laboratory areas will be provided unhindered by unnecessary partitions that might restrict maximum flexibility. These areas will include the most modern equipment necessary for continual adaptation of the curricula to assure that the preparation given the student is kept abreast of the increased technical demands that will be made upon the future graduate.

English and History as Professional Equipment for the Engineer*

By HENRY DAN PIPER

Assistant Professor of English, California Institute of Technology

President James B. Conant's excellent little book, "On Understanding Science," is based on the premise that a scientific education trains a student to think somewhat differently from his fellows in the liberal arts. The humanist who has been fortunate enough to have worked closely with scientists and engineers will readily endorse this proposition. He finds much to admire in certain unique habits of mind which he recognizes as the distinctive—indeed, the most important—fruits of a modern scientific or engineering education. He respects his scientific colleague's ability to analyze a complicated situation into components that can be easily identified according to clearly defined and readily verifiable standards. He particularly admires the scientist's ability to establish fruitful relationships between these various components. And he looks on in awe as the scientist's synthesizing imagination successfully utilizes these new relationships to create a new and meaningful intellectual order where before there had been only uncertainty and confusion.

These, of course, are invaluable habits of mind. By means of them, during the past two centuries, scientists and engineers in laboratories, factories and drafting rooms have revolutionized western civilization.

Yet because of the immense success of the scientific method, engineers and scientists are moving out of the drafting room and laboratory today in increasing numbers. More and more we see them assuming new, different and increasingly powerful roles in society. For better or worse they are becoming "humanized," at least in the sense that they find themselves today engaged to a greater extent than ever before in the buzz and hum of everyday human activities. Moreover, technical schools, by their vigorous expansion during recent years, have tacitly acknowledged the importance of these broadened responsibilities. No one would maintain today that scientific and engineering students are being educated solely for careers in research and development. Most of them look forward confidently to jobs in which they will be expected to work closely with, and may eventually supervise, lawyers, salesmen of all kinds, accountants, advertising copy writers, personnel advisers, and all the other familiar non-scientific specialists so essential to the functioning of any busy industrial enterprise.

It is in the light of these altered professional needs that the humanist today finds himself scrutinizing engineering education. Are the peculiar habits of mind noted by President Conant as the distinctive characteristics of a scientific training really adequate professional preparation for the present-day scientist and engineer? Basing his opinion upon his own recent association with a number of these specialists in government and industry, the humanist finds himself obliged to answer in the negative. It seems to him that technical education today is not fulfilling its professional obligations when it does not supplement its traditional specialized training with certain other habits of mind based on more

* Presented at the Annual Meeting of ASEE at Dartmouth, June 23, 1952.

humanistic disciplines. His reasons for thinking so are not the familiar ones that usually accompany a plea for the cultivation of the humanities—profound and pressing as those arguments may be. Indeed the humanist is not even sure that most departments of English and history are prepared to provide the kind of supplementary discipline that he has in mind. For what he seeks is training that will teach the technical student to use the resources of good English and a sense of historical relationships to order and to communicate his specialized technical knowledge and thereby give it broader social meaning than is possible by strictly scientific habits of mind. Our humanist's arguments for such training are, consequently, narrow and very realistic professional ones. And they are based upon his conviction that scientists and engineers being educated today are destined to play more diversified and more socially responsible roles in our economy than ever before.

A Problem of Communication

The particular humanistic habits of thought increasingly needed in their professional activities by today's scientists and engineers may be conveniently classified under that much-abused but still useful label, "communication." We often overlook the fact that "communication," in a very important sense, is only a newfangled name for a much older and really much more complicated idea, that of "leadership." What, after all, is more characteristic of the good leader or executive than his ability to comprehend and to communicate effectively to others the special skills, qualities and know-how possessed by those working under him? When we admit, as we must today, that modern specialized education has failed to overcome the obstacle of communication, what we are really saying is that we are not training our students for executive responsibilities—for leadership in their respective professions. It is at this point that the humanist feels himself justified in offering a few suggestions. Leadership has always been his preeminent concern.

One of the most common shortcomings that the humanist observes in his daily professional contacts with scientists and engineers is the absence of good writing habits. It is easy to understand science's age-old suspicion of written language. Words are slippery, and they have vague and manifold meanings. Science long ago supplanted them with arbitrary mathematical symbols which could be counted on to preserve constant, precise meanings. And the language of mathematics has proved serviceable in the laboratory and drafting room. But the engineer or chemist who depends solely on this private method of communication is bound to run into trouble, especially if he is one of the cogs in the average industrial enterprise. After all, the odds are that most of his research and development work has been requested by sales, operations, legal or some other affiliate. If the research worker or the development engineer cannot make his specialized data meaningful to these more secular colleagues, he will find himself seriously handicapped. The humanist doesn't have to work very long with scientists and engineers before he notices that here, as elsewhere, advancement opens up most rapidly for the man who has demonstrated not only technical proficiency but also a capacity for relating his specialized efforts to those of his other coordinate departments.

We are all acquainted with the typical case of the young engineer who is unhappily anchored to a routine job in the laboratory control room or on the drafting board. We see him constantly passed over as opportunities for advancement open up, mainly because his value lies exclusively in his technical proficiency. He is, of course, the one who cries loudest every Thursday at "weekly report" time, and his contributions usually must be entirely rewritten by his boss. The humanist is inclined to regard this man as little more than a mere "technician," whether he is a Bachelor of Science

trained to manipulate scientific equipment, or a full-fledged Ph.D. trained to manipulate scientific ideas. In either case, if he can function only within the narrow limits of his scientific discipline and cannot, when necessary, give a larger, more complicated and more human meaning to his activities through the resources of the common tongue, then what is he, after all, *but* a competent "technician?" Is he really qualified for more varied and interesting executive responsibilities?

The Historical Sense

No less important than good writing habits as a means of communication is the historical sense. By this I do not mean merely the detailed factual knowledge of various political, military and other interesting events in the past. It is the historical sense which gives such events meaning. More precisely, the historical or time sense is that instinctive sense by means of which we habitually order and communicate past experience.

This sense, particularly in our modern historically-orientated society, is one of the most useful ways of giving a certain limited but familiar meaning to human activities of any kind, and its use should be one of the intellectual disciplines available as a form of communication for any educated man. In our increasingly specialized civilization it is practically impossible for anyone in an administrative post to possess detailed, complete knowledge of the technical activities of his various subordinates and associates. In place of such specialized knowledge the good executive must be able, when necessary, to substitute historical understanding. For the same reasons, he must also be able to reshape his own specialized knowledge historically for the benefit of his non-scientific colleagues and superiors. This requires not only good writing habits but also a well-developed awareness of the social and other contextual needs and desires out of which any given technical problem has invariably arisen. It is difficult to see how a scientist or engineer can function effectively as part of any larger cooperative enterprise if his own specialized functions cannot be readily interpreted in these broader terms.

Those of us who have watched specialists struggling with the writing of histories of their technical activities can testify to the inadequacies of a scientific education when it comes to developing a historical frame of reference. For instance, during the recent war a number of top-flight scientists and engineers heading up the various research groups of the army's atomic energy project were requested to submit historical accounts of their non-military research activities. The resulting history had been planned as a supplement to Professor Henry Smyth's well-known report on the military applications of atomic energy. It was undertaken particularly for the benefit of legal counsel, congressmen, military and other interested non-technical authorities for whom a historical rather than a highly technical and analytical account of project policies and objectives would be most informative. What particularly impressed the humanists who were also associated with the preparation and editing of this history was the inability of otherwise competent scientists to bring historical perspective to bear on their jobs—not only in the writing of these historical chapters, but in their ordinary day-to-day administrative activities. They seemed to think only in the present and the future. Accordingly, the histories that these scientists initially turned in were little more than summaries of future objectives and present needs, usually set forth in private technical language. The relation of such needs to the earlier conditions out of which they grew, and the possibility that these needs might have been rendered superfluous by subsequent history, were rarely taken into account. As a result, trained historians who were later called in to restudy these records and prepare more adequate histories, uncovered a notable amount of pertinent data essential to the efficient operation of the project's research facilities. In some instances it was found that current in-

vestigations had drifted far afield from the objectives for which they had been originally initiated. In other cases work was going on which was no longer of such high priority and from which key technical personnel might have been released for more important research. And occasionally they found current work unknowingly duplicating previously completed investigations, merely because no final reports on the earlier projects had ever been submitted.

In other words, few of these top-flight scientists had been equipped by their professional education with the historical perspective so necessary in any executive for the efficient administration of his organization. Just as rigorous scientific training traditionally makes the scientist or engineer suspicious of words as vehicles for the communication of his ideas, so he also is naturally sceptical of the processes of history. For historical time, like so many other incorrigibly human affairs, is untidy and confusing and subject to many conflicting interpretations. The scientist wants his time, like his language, stripped of these unreliable human associations and sliced up into simple units that can be readily measured on the blank face of his stop watch. This, of course, is a very understandable preference, so long as he remains in his laboratory. But written English and the historical sense continue to be traditional means of social communication. And the engineer or scientist who aspires to executive leadership must be trained to order and express his specialized knowledge in these terms as well as by the discipline of science.

Recommended Teaching Procedure

But how is this training to be carried out without further encumbering our already over-crowded engineering curriculums? Writing has been properly the responsibility of the English Department. But it is only one responsibility, and is frequently a minor one. The teacher of English is also a teacher of literature. This usually means that he is primarily interested in developing the student's insights into man's recurring problems and his high aspirations, through the study of great literary works in which the human condition has been dramatized and otherwise ordered by the creative imagination. When the teacher of English undertakes a course in writing and composition, he understandably centers it around the formal study and imitation of those traditional techniques by means of which these problems and aspirations have been transformed into literary art. Such courses relate only remotely to the technical student's need for instruction and practice in the application of good writing habits to the content of his professional studies. Besides, few English teachers are prepared—technically or temperamentally—to give him such instruction.

History departments, by and large, are subject to the same criticisms. Through appropriate courses they provide disciplined study of the many interacting forces that, in the past, have given rise to significant military, political and other important events. But they are not primarily interested in training the engineering student to be his own historian. They tend to assume the existence of a historical sense, instead of providing for its exercise and development. This may be a valid assumption in the case of a liberal arts student (although I personally doubt it); certainly it has been proved unwarranted with respect to scientists and engineers.

In view of these familiar pedagogical obstacles, my suggestions for a solution to the problem are the following. In general, I would require of every scientific and engineering student that he demonstrate, before graduation, a certain proficiency in the application of good English and a historical sense to the data of his special technical field. More specifically, I would have each student, sometime during his last two years in college, submit at least one full-dress essay dealing with some problem of this nature. His paper may be based on li-

brary research, or it may be the result of both outside reading and laboratory experiment. The subject may be a personality, an idea, an institution, or any combination of these topics. But, above all, it should be a subject of genuine professional interest; one that has aroused the student's enthusiasm and stimulated his imagination. Only then will he care enough about what he has written to benefit from criticism and advice.

The solution outlined so sketchily here is only a tentative one, and can be easily modified. At this stage of the discussion the particular habits of thought that such essays should develop are much more important than the several alternatives by which they can be secured. The main advantage of the full-dress extra-curricular research paper is that it can be introduced as a blanket requirement at any time without raising the question of new or changed course-work. An attractive alternative might be the optional substitution of a paper, or papers, prepared in already established courses—such as courses in technical or advanced English composition, or in the impact of science and technology on the history of western civilization.

Finally, I would require that the essays be read and judged by the student's professional advisor as well as by a second reader drawn from either the English or history staffs. A satisfactory essay should give evidence not only of the writer's technical proficiency, but also of his ability to place his data in a historical framework, and to write about it clearly, accurately and interestingly. Without this ability can we say that any student has really mastered his professional discipline, or that he is educated in the true meaning of that word?

Reserve this date . . . .

June 22-26, 1953

ANNUAL MEETING

UNIVERSITY OF FLORIDA

GAINESVILLE, FLORIDA

Industry's Stake in A.S.E.E.

. . A Message to Industrial Management

By J. C. McKEON

Chairman Associate Institutional Membership Committee; Manager, Educational Department, Westinghouse Electric Corporation

The Associate Institutional Membership Committee of A.S.E.E. is now launching its major industrial membership drive, after a most successful pilot operation, which increased memberships from three to thirty-five.

The following article is being printed in booklet form for use in connection with the Committee's campaign to interest industry's top management in A.S.E.E. Associate Institutional Membership.

As an individual Society member, if your company is not listed in the Yearbook Issue of the Journal on the Associate Membership roll, page 36, would you please place this article with the accompanying application blank before the appropriate committee.

The development of technical and management talent is a most critical problem facing top management today. The future prosperity and progress of every industrial concern depends upon a constant flow of competent people and ideas into an organization. The increasing complexity of industry's problems requires a higher level of technical and professional competence. Nothing is more fundamentally vital to a company than a sound professional personnel program for leadership development.

Enlightened management recognizes its partnership with the universities in maintaining effective programs for the recruitment, training, continued education, and management development of professional people. Industry looks to the enginering colleges for a source of technical manpower and a reservoir of fundamental knowledge. Many companies, however, are not fully aware of the assistance the colleges are prepared to render. The value of satisfactory arrangements for the recruitment of seniors and the handling of research projects is apparent. Less apparent, but of equal importance, is the value of joint graduate study courses and advanced management development programs for professional employees. The education and development of our future leaders requires a cooperative effort.

Membership Dividends

Industry's stake in engineering education and the American Society for Engineering Education is vital. A.S.E.E., the official professional organization for engineering education, has guided the college engineering programs to their present high level. Membership in this great Society is not only an honor, but offers many tangible benefits to industry. A.S.E.E. provides a channel of communication with the policy makers of the universities, a forum for discussing problems of mutual interest, and the machinery for implementing programs. Effective programs with the colleges can be maintained only through industry's close cooperation with the college deans and the faculty members. Participation in A.S.E.E. gives the industrial manager an opportunity to gain firsthand, an understanding of the problems of the colleges and to inform the college personnel of his company's needs and problems. Association with the college

faculty members in the common cause of the engineering profession promotes mutual understanding and respect.

Associate Membership representatives will find participation in the Relations with Industry Division of the Society rewarding. It is composed of an active group of industrial and college faculty members. In addition to building good relations between industry and the colleges, a number of noteworthy studies concerning industrial training, qualities necessary for success in industry, a speaker's manual, teaching aids, technical job descriptions, selection of college graduates, and graduate study in industry were conducted.

In addition to the activities of the various divisions, Associate Members will be interested in participating in the Society's annual meeting, which is held on one of the college campuses, and the periodically scheduled regional meetings at various educational centers throughout the country. Each year, the Division of Relations with Industry sponsors a College-Industry Conference, in addition to its conferences at the Annual Meeting of the Society. These activities are attended by representatives from industries throughout the country. Associate Institutional Members receive a subscription to the *Journal of Engineering Education,* the official publication of the Society, and a copy of the *Proceedings* without extra cost.

Associate Institutional Membership entitles industrial concerns to participate in two of the three governing bodies of A.S.E.E., the Engineering College Administrative Council, and the Engineering College Research Council. The third governing body is the General Council, an elective body, in which Associate representatives may serve. The Engineering College Research Council is comprised largely of directors of research, deans of engineering, and research directors of industry. This Council makes recommendations to the engineering colleges regarding research policies, and serves as a common meeting ground for those interested in research developments.

Industrial members will find that along with the many advantages Associate membership provides, there is the opportunity to serve education and the engineering profession by assisting the colleges in the development of young men and women for professional careers and good citizenship.

Organization of A.S.E.E.

The Constitution of the Society provides for two classes of members—individual and Institutional. Although the majority of the 7000 Individual members are college administrators and faculty members, a substantial number of industrial people hold Individual membership. There are three types of Institutional members: Active—for accredited engineering colleges (every engineering college in the U. S. having one or more accredited curricula is a member); Affiliate—for educational institutions which are not eligible for Active membership, which includes 27 members; and Associate—for industrial organizations with a major interest in engineering education. Associate Institutional Membership presently includes the 35 companies listed below.

Associate Institutional Membership dues are $50 a year. The Society's fiscal year is from July 1 to June 30. Companies applying for membership after February 1 will be billed for one-half year's dues and will receive a copy of the *Journal* starting with the February, 1953 issue.

The Associate Institutional Membership Committee extends your company a cordial invitation to participate as an Associate Member in the activities of A.S.E.E. Please complete the application blank today—Associate Membership in A.S.E.E. is an investment in your company's future.

Please return this application to:

THE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

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Professor A. B. Bronwell, Secretary
American Society for Engineering Education
Northwestern University
Evanston, Illinois

The undersigned company or association desires to become an Associate Institutional Member of

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and hereby agrees to conform to the requirements of membership, if elected.

Name of Company .....

Headquarters Address .....

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Membership Representative .....

Position .....

Address .....

Mailing Address for *Journal of Engineering Education* and Announcements

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(Note: Unless otherwise specified, dues notices will be sent to the membership representative.)

Date ....

Print or type Name of Officer or Other Person Authorized to Apply for Membership

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Unit Operations for Mechanical Engineers

By CHARLES A. BESIO

Associate Professor of Mechanical Engineering, Southern Methodist University

AND

DR. HAROLD A. BLUM

Graduate Lecturer in Mechanical Engineering, Southern Methodist University, Research and Development Department, The Atlantic Refining Company

Unit Operations for Mechanical Engineers

To speak of teaching Unit Operations to mechanical engineers may produce two reactions; from the chemical engineers the cry that we are trying to mix fields; from the mechanicals, assuming they know what Unit Operations involves, the query, "what's that have to do with us?" We would like to show that such training is now necessary and that it is another case of needed preparation of one group to work with another.

Lately, an increasing number of mechanical graduates have been integrated into process industries and allied fields. This has emphasized a serious shortcoming in their training. These men find themselves ill-fitted for their tasks. This is true, either because in their training they were exposed to few if any of the basic processes employed in this field, or if they had been, they shied away from it like a fox from a baited trap. It has been our experience that the adjective "chemical" has a frightening effect on all but chemical engineers, particularly while they are students.

A sizable number of young engineers came to us looking for courses to help fill this void; men working in the petroleum industry who knew little or nothing about fractionation and distillation equipment; men working as mechanical engineers for chemical concerns who needed to know about gas absorption; men working for steel fabricators who knew nothing about bubble plates or the function of the unit in which they were placed, and yet were supposed to design these units for fabrication. To assist these men, we decided to offer a course for non-chemical engineers to cover the field of unit operations.

As these men were all graduate engineers, the course was given on a graduate level. It was not our intent to make chemical engineers out of mechanicals, but rather to acquaint them with the language and methods of unit operations so they could work more effectively with chemical engineers.

The course required forty-eight hours of instruction and was offered to a group of fifteen students in the Fall Semester of 1951–52. In the following sections we will outline the teaching objectives, subject matter covered, and give our evaluation of this initial course.

We would like to acknowledge the invaluable assistance given by some of the original students in pin-pointing many of the strong and weak points discussed.

Teaching Objectives

The specific objectives of the course were:

1) To teach the principles of the various unit operations, which amounts to semi-quantitative consideration of some phases of physical chemistry.
2) To focus attention on the application of energy and material balances to the design of unit operations such

as fluid flow, evaporation, and distillation, and

3) To emphasize the economic factors involved in process engineering by means of practical problems.

Subject Matter

The following is an outline of the subjects considered in this first course:

I. Introduction
  A. Definition of Unit Operations
  B. Examples
II. Fundamental Concepts
  A. General Approaches to Unit Operations
    1. Material Balance
    2. Energy Balance
    3. Equilibrium Concept (Dynamic)
    4. Rate Concept
  B. Basic Definitions and Laws
    1. Definitions of Chemical Terms (Mol, Chemical Formula, equations, Mol Fraction, Mol Volume)
    2. Gas Laws (Ideal Gas, Dalton's Law)
III. Flow of Fluids
  A. Pipes and Fittings
    1. Types and Uses of Pipes
    2. Pipe Layout Design and Cost Estimating
  B. Energy Relations
    1. Energy Balance Equations (General)
    2. Dimensional Analysis and Resistance Concept
    3. Design Problems
  C. Measurement of Flow Rates
  D. Pumping and Compressing
IV. Heat Transmission
  A. Conduction
  B. Convection (Emphasis on Calculations of Heat Transfer Coefficients)
  C. Radiation
  D. Heat Exchanger Design
V. Evaporation
  A. Background (Definition and Examples)
  B. Types of Equipment
  C. Physical Principles
    1. Boiling Point
      a) Defined
      b) Vapor pressure
      c) Effect of temperature
      d) Non-volatile solutes
      e) Effect of total pressure
    2. Boiling Point Rise Charts
  D. Evaporator Design (Economic Number of Effects, Method of Feed)
IV. Gas Absorption
  A. Background
  B. Type of Equipment
  C. Physical Principles of Gas Absorption
    1. Steady State Conditions
    2. Solubility Equilibrium
    3. Rate of Absorption
    4. Two Film Theory
    5. Mass Transfer Coefficients
  D. Absorption Tower Design
    1. Material Balance
    2. Rate Equation Integration (Tower Volume Determination)
    3. Transfer Units
    4. Channeling, Flooding
    5. Problems
VII. Distillation
  A. Background
  B. Types of Equipment
  C. Physical Principles of Distillation
    1. Scope of Study
    2. Ideal Solutions
    3. Raoult's Law
    4. Boiling Point Diagrams
    5. Composition Diagram (Constant Pressure)
VIII. Plate Calculations—Binary Systems
  A. Definition of Theoretical Plate —McCabe-Theile Method for Calculation of Number of Theoretical Plates in a Fractioning Column
  B. Optimum and Minimum Reflux Ratio
  C. Plate Efficiency
IX. Mechanical Features of Fractionating Tower Design

A. Vapor Velocity
B. Liquid Velocity
C. Principles of Design of Risers, Downspouts, and Bubble Caps

Evaluation and Recommendations

To determine the subject matter which should be included in a course of this nature cannot be done in a single step. After once presenting the course, it was decided to attempt to discover its deficiencies by means of a questionnaire filled out, anonomously, by the students.

In addition to the questionnaire, the results of short examinations, outside problem solutions, and informal comments by students aided in evaluation of this course.

From this information was gleaned the answers to three questions; first, how well the subject information was absorbed; second, what the student felt was needed in the way of previous study or preparation; and third, to what extent the course filled the students' requirements. A fourth question was answered by inference, that of how good a preparation the student had for the course material.

The answers to the above questions led to one very definite conclusion. The normal undergraduate training received in mechanical engineering tends to minimize, and even neglect, a basic understanding of chemistry and its applications. Even the psychological attitude of most mechanical engineers is against chemistry in all forms, as can be well realized by those who have labored to get across an understanding of combustion to undergraduates in thermodynamics and heat power. There is a definite need to create a respect, and to a greater extent an appreciation, of applied chemistry.

It was obvious from the result of that part of the survey to determine subject absorption that this basic training deficiency was present. Those subjects which depended upon basic understanding of material closely allied to mechanical engineering were well taken, while those based on knowledge of physical chemical principles were not absorbed as well.

It will therefore be necessary to add to the course a study of chemical process calculations. This must be done in such a way that an interest in the general subject is aroused by eliminating the vague generalities and associating the subjects to specific problems in which the student has a basic interest.

All of the students seemed to have some desires to cover additional unit processes which time did not permit in this course. This fact, coupled with the need for more introductory material, seems to indicate that six semester hours, or possibly even nine, will be needed to present Unit Operations to men trained as other than chemical engineers.

In considering the problem of covering all the subject matter desired, two possibilities present themselves. The one is to condense the time allotted to each individual operation; the other is to extend the course to six semester hours in length. Of the two, we feel the latter is more desirable.

To condense any of the material covered would mean that many subjects would only be superficially studied. This would leave a serious void, and not accomplish the primary purpose of the course. If the course were extended, all material, introductory in nature, could be sufficiently covered and enough time could be spent on each unit operation to allow sufficient discussion and problem solution to give complete coverage. Then, if the demand for more thorough familiarization arises, still another three hours could be used in the solution of actual or simulated plant design problems, keeping in mind that the mechanical aspects of the problem are paramount.

In spite of our limited experience with this course, we recommend that serious consideration be given by engineering schools to the idea of a unit operations option, either on the undergraduate or graduate level. We believe that this will increase the stature of the mechanical engineer in process industries and result in improved efficiency of process operations.

A Mathematics Foundation for Industrial Engineering*

By HOWARD P. EMERSON

Professor and Head of Industrial Engineering, University of Tennessee

Engineering has always been built on a foundation of mathematics and the basic sciences.

The trend today is toward greater use of mathematics. The Committee on Adequacy and Standards of Engineering Education of ASEE recently concluded that "the greatest potential for future development in science and technology is to be found in mathematics."[1] Engineering fields other than Industrial Engineering are finding growing need for a better foundation in mathematics and for mathematical courses higher than calculus.

For example, in the Southeast, curricula are beginning to be influenced by three big projects: atomic energy development at Oak Ridge, the Arnold Engineering Development Center at Tullahoma, Tennessee, and TVA with its regional electric power system. All of these projects maintain teaching or research relationships with the engineering colleges of the Southeast. The mechanical engineers are finding a need for higher mathematics for wind tunnel and jet propulsion calculations, the chemical engineers need higher mathematical analysis for atomic reactor design, and the electrical engineers have long required courses in differential equations since rates of change dominate their fields of study.

What about the industrial engineers? Do I. E. students already get enough mathematics or will Industrial Engineering follow the path of other engineering fields which also started with practical, rule-of-thumb methods but have become more and more dependent upon mathematics?

This program today on "Mathematical Analysis in Industrial Engineering" is intended to explore this question. In preparation for it one of the participants made a significant discovery—that it was hard to find industrial engineering applications of general mathematics, other than arithmetic and algebra, but further that there are "few applications of mathematics to industrial engineering problems that do not involve some aspects of statistics."

This discovery raises two points for consideration:

1. What present or future industrial engineering problems require mathematics in their solution and what are the mathematical techniques which the industrial engineer needs to solve them?
2. If most of the applications of mathematics are found to involve some aspects of statistics, is not this the logical field of specialization for Industrial Engineering?

Mathematics Courses Needed

Most of the conventional mathematical techniques, with the exception of statistical mathematics, are probably included in what I. E. students get now. At least this is what we found at the University of Tennessee, where a recent review of mathematical requirements common to all en-

* ASEE Annual Meeting, Industrial Engineering Division, Dartmouth College, June 25, 1952.

[1] S. C. Hollister, C. S. Crouse, L. F. Grant, and M. D. Hooven, "Report of Committee on Adequacy and Standards of Engineering Education," *The Journal of Engineering Education*, 42: 249–254, January 1952.

gineering fields suggested that few new topics needed to be added in the existing subject matter. Our engineering faculty adopted a requirement, which goes into effect this fall, of 5 hours each quarter in mathematics for the first two years, a total of 30 instead of 24 quarter hours in a common unified course for all engineering students. This unified course starts with differential calculus in the second week of the freshman year and ends with a brief introduction to differential equations. It is hoped that this will answer the objection of all departments requiring advanced work in mathematics that poor preparation limits performance in higher mathematics courses.

On such an expanded two year mathematics foundation later courses can be added if they become desirable. What would be such higher courses for the industrial engineer? One might be matrix algebra, useful in solving simultaneous equations and reaching decisions on optimum situations involving many variables. Differential equations may not be necessary since most of those industrial engineering phenomena involving rates of change can be handled by integral calculus. In the new field of cybernetics, involving substitution of mechanical for human brains in the form of computing machines, the industrial engineer already uses IBM punch card equipment and automatic calculating machines of ten digits, and these may be adequate for some years to come. In another new field, operations research, statistical mathematics comes into play.

Statistical Mathematics

The major exception not covered adequately in the basic two year mathematics course for engineers is mathematical statistics. Engineers have lagged behind in using statistical methods. Nearly every other profession has made use of them. If Industrial Engineering follows the trend of other engineering fields in requiring advanced mathematics in undergraduate or graduate work, I believe its field of specialization will be that of mathematical statistics. Statistical methods have already opened up new opportunities. They have brought striking results in quality control. But control of quality is only the beginning of the applications of mathematical statistics to manufacturing and manufacturing research.

Furthermore, some of the older industrial engineering techniques themselves, such as time study and methods evaluation, can be improved by statistical analysis.

A Subcommittee on College Courses of the American Society for Quality Control recommends one year of basic and applied, mathematically sound, statistical courses (9 quarter hours) as the eventual goal for all engineers.[2]

On the basis of all of this I believe the industrial engineer should "latch on" to statistical mathematics as the most productive of the mathematical fields. The industrial engineer should become the leader in developing engineering applications of it.

If this is a logical conclusion, how should industrial engineering students get their training in statistical methods? All of us throughout the country have been trying out different ways to accomplish this.

Probability Theory in Basic Math Courses

One suggestion is to include more probability theory in the first two years of mathematics. The new unified math program which I mentioned will include not only work on the binomial theorem and the method of least squares for fitting data, but an introduction to probability and statistical methods including permutations, combinations, the normal probability curve and correlation. I believe an introduction to these topics will get around a road block which seems to delay students in grasping probability mathematics.

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[2] *Industrial Quality Control*, Vol. VI, No. 4, January 1950, pp. 27–30, "Statistics and Quality Control in Engineering Courses," Report of Subcommittee on College Courses, ASQC.

Statistics Courses for Engineers

There are three phases to this unique field of statistical mathematics:

1. *Applications* by industrial engineers in plants. (Setting up control charts, introducing sampling plans or procedures, designing plant experiments.)
2. *Statistical techniques* required for these applications (such as the normal distribution, Poisson table, correlation, t-test, F test, analysis of variance, Latin square).
3. The *mathematical basis* for these techniques (such as proofs of formulas, the derivation of the data in statistical tables, mathematical properties of the normal curve and the whole concept of probability).

In view of this three-dimensional aspect of statistics for engineers, it is a knotty problem to decide who should present this subject to the undergraduate. One position we can take at the start: the engineer should teach the applications of this or any other method in engineering. The use of statistics is simply one means to an end. Departments of statistics teach the statistical techniques, but do not purport to do more than indicate how the formulas and tables were derived. If we turn to the mathematics department, which engineering colleges have been accustomed to doing in other mathematical fields, we run into a number of problems. One is the problem which we have faced in calculus, that math departments sometimes seem to have little interest in practical examples and may confuse the student with mathematical procedures, proofs of theorems, and derivations of tables, losing the students' interest. In the case of statistics this is tragic for it is a fascinating new field for the engineer.

Problems of Presentation of Statistical Mathematics

A further problem in building this foundation of statistical mathematics for industrial engineers is the type of presentation. Should each formula or table be backed by rigid proof? This will indeed get into matrix theory and the geometry of hyperspace, for some of the proofs in the field of statistical mathematics are as difficult as they come. Industrial engineering students who take statistical mathematics will find it as high level work as the mechanical or electrical or chemical engineers face in the higher math courses which they may take. Mathematical statistics is not easy.

Finally, shouldn't we think of statistical mathematics, not as an area of specialization, but an integral part of common core mathematics?[3] It is needed especially by industrial engineers but is eventually to be of use to all engineers. I believe this is in line with recommendations of the ASQC.[4] Teaching of both mathematics and engineering will need to be reoriented.

With manifold applications of statistics ahead of us, would the engineer not be wise to turn to mathematics as the basic, first-hand source of the theory to be applied?

Conclusions

The answer to the question of how much mathematics the industrial engineer should have, and how to present it, depends upon our concept of the industrial engineer and the relative emphasis on basic science and mathematics vs. applications

I discussed this whole problem with a practicing industrial engineer in a metal working plant who came to us recently looking for graduates. He said, "Just teach them to add and multiply."

I next discussed it with a consulting industrial engineer who had recently returned from Europe, where he found that industrial engineers are beginning to use higher mathematics. He said, "I feel that the industrial engineer in the future will be using some of the computing machines and matrix algebra. I believe that he should have a thorough grounding in statistics which should be taken after he has completed his calculus and probably

[3] Everett Laitala, Correspondence dated June 4, 1952.

[4] ASQC Subcommittee, *op. cit.*

should take matrix algebra at the same time."

In the light of these conflicting comments this paper suggests the following conclusions, in summary:

1. Many opportunities exist for using mathematical analysis in Industrial Engineering. This can be confirmed by making a list of mathematical techniques, both in general and statistical fields, and in a parallel column present or potential applications of each in Industrial Engineering.

2. Most of us have failed to make full use of these mathematical methods, but Industrial Engineering is not the only field which suffers from this failure. One reason for the reluctance to use mathematics by student, teacher, and plant engineer is that thorough understanding of mathematical analysis and practice in its applications are not provided in undergraduate work.

3. It is not enough to make "mere translations from a literary form of expression into symbols, without any subsequent mathematical analysis."[5] Not only economists, to whom this quotation has reference, but also industrial engineers in handbook style do this in such expressions as:

$$R = Y + C + E + F + M + L + T.$$

4. In order to bring about greater use of mathematical analysis in Industrial Engineering a firmer foundation of mathematical training needs to be provided for beginning students. One solution may be more hours devoted to the present mathematical subject matter. Another may be the so-called "unified" approach, which is being presented and discussed in the Mathematics Division of this conference.[6]

5. As "A Mathematics Foundation for Industrial Engineering" this paper suggests that two years of fundamental mathematics, more complete and thorough than it is now given, can provide the industrial engineer with many techniques which he might be encouraged to use more than he does at present.

6. Expanded emphasis on fundamentals can also provide a solid foundation for advanced mathematics courses or study. If such advanced work is needed, the first promising new field for industrial engineers is that of statistics or mathematical statistics. Other new fields like matrix algebra and symbolic logic can be investigated by gifted students through choice of electives or thesis investigations.

[5] John Von Neumann, and Oskar Morgenstern, *Theory of Games and Economic Behavior*. Princeton: Princeton University Press, 1944.

[6] W. R. Van Voorhis, "An Integrated Approach to Basic Mathematics."

Are We Ready to Consider a Major Change in Policy?*

By W. S. EVANS

Professor of Civil Engineering, University of Maine

Engineering—An Art or a Science?

The one piece of legislation most often mentioned in educational circles is probably the Morrill Act. Since this Act was signed in 1862, I am going to start off by saying that ninety years ago, our fathers made possible for future generations a new kind of education. Although it is not necessary for me to tell you that the part of this plan in which we are most interested was labeled, "Mechanic Arts," I remind you of it to emphasize that the forerunner of Engineering Education was thought of as an art. Of course, engineering was in those days, and still is, a mixture of art and science; but just as we can all agree on this, so I think, we can all agree that the mixture, the ratio of the part attributable to art to the part attributable to science has changed.

As evidence of this it is found that from the structural standpoint, present day writers credit the discovery or creation of the various styles of ancient architecture, the Greek Doric and Ionic, the Roman Arch, the Gothic Vaulting, to their creators as artists not as scientists or engineers. While the results were engineering accomplishments, they were arrived at by intellectual and physical processes which characterize an art rather than a science. Of course the originators of these ancient styles of architecture were great architects and engineers but their accomplishments seem to have been derived from art, not science. Great strides had been made prior to the middle of the nineteenth century, but when the Morrill Act was signed, there was still a close linkage between the craftsman and engineering accomplishments. As examples of what I mean, study the old covered bridges of New England and the type of building construction which required four-feet thick walls. I once had a well-known bridge engineer explain to me how he could determine accurately the bearing power of a soil by the kind of imprint his heel made upon it. I have no doubt that he could, but it was through ability developed as an art and not through scientific deductions that he was able to make such decisions.

When Frank Lloyd Wright built the first modern home, the exterior of which was not determined by conventional appearance but by the interior demands based on a utilitarian use of space, he began to take the art out of architecture. It is worthy of note that while the types of architecture developed in the remote past are attributed to the great artists of the time, the modern skyscraper in all its many styles, in fact most of the modern developments in architecture, are attributed to the engineer. The point I wish to make is that while 2000 years ago a structure had to be created by a master much as painting was created or a statue was modeled, today design is based on fundamental principles and concepts which may be acquired by anyone who possesses the will to do so and the necessary mathematical background.

* Presented at the 60th Annual Meeting of ASEE, Dartmouth College, June 23, 1952.

Service is the Yardstick of Engineering Accomplishment

You may be wondering just what this has to do with our subject. We have been asked to investigate and evaluate our present engineering curricula. To investigate is difficult unless we know the purpose of our investigation and to evaluate is impossible without a standard of measure. Then we should first determine what we are to measure, second, establish a standard by which to measure it, and third, make such investigations as are necessary to apply the standard.

Rather than measure the success of our educational program as it affects the individual and the employer, let us consider its effectiveness as a service to the public. Let us consider such questions as "Is Civil Engineering as a science progressing satisfactorily?"; "Are the structures we build the safest and most economical possible with the men and materials available?

As answers I would like to present a few observations. Three years ago there was built on the University of Maine Campus two fairly large buildings with reinforced concrete frames. Today, in the third year of their use, bad cracks are opening up under the spandrel beams at the roof level. Why? Two years ago at Seattle, a representative of the Portland Cement Association, told this group that we were 20 years behind the times in what we were teaching in our Concrete Courses. That gentlemen, is why those buildings are cracking. We don't understand Reinforced Concrete Design as we should. At Seattle, when that statement was made, we, not all of us, but you and I, rose up and said we couldn't do any different as we had to teach design according to the present specifications, and now I remind you of the title of this paper, "Are We Ready for a Change?"

Last summer, while travelling from Pittsburgh to Harrisburg over the Pennsylvania Turnpike, the most extensive superhighway in the country, I counted ten repair crews working on the roads in each direction, 20 in all, replacing broken down slabs and I am told it has become worse since then. From one coast to the other we find roadways pumping mud, pavements beaten up and broken down. And why? There aren't enough engineers who understand the necessity for sufficient foundation under our highways and who possess the will to obtain such understanding. The men who will be in the key positions in our highway departments 20 years from now are in our institutions this year. Will they be the right men for the positions, unless we are willing to make a change?

Theoretical Analysis and Technical Development

I'd like to give more examples in more fields but time doesn't permit. I am going to take time to ask a few more questions.

Is it accident that many of the leading mathematicians and scientists in this country were foreign born? Of course you can answer that, in many cases, circumstances forced them to this country and we have educated some great scientists too, all of which is true. Then I would ask "Is it accident that most of the original work on prestressed concrete was done in Belgium and France?" But, you can say, shortage of materials forced its development and I would remind you that, having been shown its use, we don't seem to find it such a bad economy either.

No, these things have not occurred by accident. The pattern is too clear cut. The Europeans have excelled in originating those things which can be derived from a background of fundamental theory. The reason is clear. The philosophy of Engineering Education in Europe is based on theoretical treatment of problems in hand. Ours is based on a practical treatment. Again I ask "Are we ready for a change?"

Requirements Change

Through the wisdom of our legislators in 1862, our engineering schools were

founded as "Colleges of Mechanic Arts." This was just and proper but times have changed. Civil Engineering in 1862 consisted largely of surveying and bridge building, with the building of canals and dams next. The field was narrow, the students few, and the instructor would pass on his skills with ease and effectiveness, but we are working under a different set of rules in 1952.

The American Society of Civil Engineers lists 14 Technical Divisions. If we consider 12 functional divisions for each one of these technical divisions, then we get 168 different classifications. Actually there are many more. So we see that since 1862 Civil Engineering has broadened to fields unheard of at that time. In the meantime it has become much less of an art and much more of a science. I cannot feel that our curricula, our methods or our philosophy have changed in proportion.

Our Objectives Should Change

You may well ask just what I mean by a change in Policy. I'm not sure I can explain it in a few moments, but I can try.

Let's start with Soil Mechanics. It was my fortune some thirty-four years ago to be subjected to a course in Foundations. As I remember the study consisted of a very rough classification of soils and a prolonged study of existing structures and their behavior. This was a common procedure, but Soil Mechanics as a science could never have developed from this kind of a foundation. When a scientist, properly trained, undertook to find out what happens to a particle of soil subjected to stress, Soil Mechanics, as a science, began to develop and it couldn't have developed any other way.

If we ever hope to design concrete structures on anything approaching a scientific basis, we must study the particles of concrete and their behavior from the time the mass is placed until it has been subjected to service for a period of years. In much of our structures work, the student gets the idea that he is studying specific structures rather than fundamental principles of stress analysis. It seems that in many cases we actually teach a few isolated applications instead of fundamental theory applicable to a broad field.

The change I am talking about requires no radical changes in our methods or curricula but it would require a change in our objectives and attitudes toward what is expected of a man with the B.S. degree. The young graduate should not expect $5000 for his first year's work and his employer should expect to offer a longer period of training and less immediate returns. In brief, we should hold the four-year curriculum for those things which can best be taught in the atmosphere of an institution of higher learning. We might adopt some such motto as "The Sciences for the student, the Arts for the practitioner." We must ever strive to increase the ratio of science to art in our engineering work and thereby continually whittle down on the factor of ignorance. This will require a change in our philosophy.

Are we ready to face that change?

The Role of the Instructional Staff in Extension Development

By M. D. ADAMS

Assistant Professor of Physics, Purdue University

Campus and Extension Relationship

Insofar as the program of the Extension is a duplicate of existing campus functions, adequate machinery and controls are available through the existing Departments of the University and administrative organization. Purdue University has been extremely wise in extending intact these time-tested controls to similar off-campus activities. It is not the purpose of this analysis to question this existing organization or its adequacy to do off-campus the same job that it does on-campus.

But the Extensions represent a pioneering movement, in a sense, into new fields and heretofore undeveloped phases of technical education. There are consequently problems associated with them which are not shared by the campus organization but are unique with the Extensions. For the solution of these special problems, the campus-directed organization alone cannot do the job that progress and the urgency of "today" demand.

Some Extension Problems

What are these specialized problems growing out of specialized functions?

Very briefly summarized, the basic facts and conditions concerning the Extension Program which differentiate it and its problems from the campus program are these:

1. Extension students usually live at home with the attendant advantages in economical living but disadvantages of transportation, disturbing home influences on study, and absence of many campus cultural influences and developing experiences.

2. Extension students are combining "Earning and Learning" to a far greater extent than are campus students, and have the accompanying problems of time-budgeting, overwork, and health hazards.

3. Much of the program of the Extension falls into the classification of adult education with its part-time, older night students. This necessitates a wide departure from the formal and traditional classroom methods to those better adapted to adult education.

4. In the college-credit classes, more and more students of border-line ability-level are using the Extension for a "try-out" period. The result is more stringent demands in the field of guidance and a greater premium on instruction and instructional effort than with the higher-ability average of students on the campus.

5. The terminal two- and three-year programs of the Technical Institute are exclusively specialized Extension activities with all of the attendant problems of working in a new field in close cooperation with local industries whose needs the program serves.

Some Conclusions

From such a hasty sketch, what should be our conclusions?

Over-all generalizations are difficult to make, but this Extension program clearly implies that some of its greatest assets will be:

1. Flexibility, sensitivity for, and close coupling to community needs.

2. An atmosphere of genuine interest, and wholehearted helpfulness in guidance and learning processes.

3. Over and above all, a very high caliber of instruction, based on mastery of subject material, knowledge of teaching techniques, and understanding of students and their individual needs.

4. Facilities for making this program effective.

All of the adequate adaptations and adjustments needed to bring the operative program more closely into line with the above goals and objectives of the Extension cannot be made, with complete success, by long range from campus offices but must be made largely on the front lines by front-line operatives. Such adjustments can only be achieved gradually through the years by responsible, wholeheartedly interested, pioneering staff members wrestling daily with their very real front-line problems. Without utilizing the initiative and originality of these active instructional staff members, the Extension will never take on that distinctive character that it must assume if it is to survive and meet its highly specialized objectives and obligations.

Neither will it be sufficient to staff the Extension with energetic, ambitious, and far-seeing administrators who have the vision to understand the role of such an institution in the community, if that administration acts on the principle that adequate progress can be accomplished by "executive edict" from the top down. Certain achievements may ensue from such controls, but cooperative team work between the entire staff *on the job* can alone attain the highest goals. Far worse would be the situation if any Extension should ever become tied down to men of small administrative stature to whom the instructional staff would look in vain for the constructive leadership so essential in any cooperative endeavor.

Some Suggestions

How best, then, can the cooperative efforts of the entire staff be directed and guided to achieve these common, desirable, specialized goals of the Extension?

Before constructive, cooperative work can be achieved, correct attitude and morale among staff members toward the entire program of the Extension must be secured. Somehow there must be engendered in each member a feeling of personal and group pride in the work being done. Little progress can be made as a group until each person accepts the responsibility, not only of doing his own specific work well, but of promoting the common welfare of the Extension wherever possible.

If the work of the staff is to be properly coordinated, it cannot be sporadic or unorganized. Concerted group action can only function where responsibility and authority are clearly defined, understood, and generally accepted.

Of course, it is possible for a staff to mire itself down in the maze of its own organization with a multitude of nominal committees and officers whose functions are poorly understood, whose authority and responsibility are undefined or at best hazy. It is of utmost importance that the administrative and instructional staff mutually define, or re-define, and establish these relations so clearly and openly that no doubt can exist, or the feeling ever prevail that where the program fails it is "your" failure, but where it succeeds it is "my" success. Where authority is needed, it must be clearly granted and the accompanying responsibility accepted. Where decisions are to be made within the province of the staff, they must be made only in the democratic manner by the groups concerned.

Attitude, however good, and organization, however efficient, do not of themselves alone guarantee sound development of the Extension. The staff will never be capable of doing the required constructive thinking, planning, and deciding unless thoroughly and painstakingly fortified with all available knowledge and facts pertaining to the Extension at all times. The staff must be supplied with all of the information available as soon as it be-

comes available. This cannot be left to chance, or the "grapevine" but must be supplied by definite, well-planned channels.

A mimeographed news bulletin published weekly through the cooperative effort of administration and staff would appear to be of value and to be recommended. More bulletin material on a large bulletin board available only to the staff might be utilized. Not only is basic information about courses, classes, hours, objectives, etc., necessary to the staff for constructive thinking, but also every staff member is and should be more or less a public relations agent for the school wherever he may go in the community. He can function in this capacity only to the extent that he is well informed.

The effect on staff attitude and morale in being in "On the Know" is great; because with this sharing of the knowledge and plans comes the feeling, "This is MY school. I am a vital part. I am not a mere observer or passive employee. My achievements are given fair recognition."

While the problems in the various departments may vary widely, there are still many problems common to all Departments and all staff members of the Extension. It is important that these problems be faced cooperatively by the staff. A definite schedule of professional meetings devoted to planned exchange of ideas and experiences on these specialized common problems should be a vital part of the yearly plans of operation. The content of such meetings would be both inspirational and informative in character. These discussions would serve the double purpose of informing and at the same time welding the staff into a genuine professional group, understanding and working together to achieve common objectives. Such meetings are not to be confused with administrative meetings held at rare intervals for clarifying administrative details only.

Orientation Meetings

The specialized objectives of the Extension are such as to place superior instruction at a high premium. This should be one field in which the smaller Extension located in its own geographically small community, with closely integrated staff, should be able to excel the campus organization. Circumstances, however, make it necessary to utilize instructors who have not always been well prepared in the "art" of superior instruction. Especially is this so with the many part-time instructors from industry who, in some cases, have had no previous experience in teaching although well grounded in their own specialized fields of knowledge and skills. Therefore, it would appear to be advisable that in addition to the professional meetings mentioned above that there should be carefully planned orientation meetings for new instructors and part-time instructors. These meetings could well be planned for weekly intervals covering from one to two semesters. Attendance and participation could be made a part of the teaching contract. If the supply of potential instructors in the community were large enough to justify it, there might come a time when attendance at such a series of meetings could be made into a prerequisite for employment later and thus build up in the community a "backlog" of properly or partially oriented and trained instructors in various fields for part-time or even full-time employment. The content of such meetings would include not only instruction in the basic objectives of the school and the administrative details of operation, but carefully planned and functional instruction in the art and techniques of good teaching.

This orientation program would utilize instruction that is now available at most of the centers in the form of key instructors who have demonstrated themselves to be superior teachers. There is no reason to believe that such added duties would be an additional burden. They should be part of the regular teaching load of the key instructors. To most teachers, such selection would come as an honor and a personal challenge to increase further their service to the institution and to their students.

Associated with this in-service training is recommended closer cooperative supervision of the actual conduct of class instruction. The nature of the instruction that takes place is so vital to the institution that every opportunity for improving and maintaining the best must be utilized. A few poor spots in instruction, as well as a few rare cases of perniciously poor practices and attitudes, may do more harm to the entire program than a far greater number of superior instructors could offset. Cases of poor teaching practices must be eliminated through constructive supervision plus the united pressure of faculty group-opinion to attain excellence of instruction.

Dual Nature

The administration and direction of the Extension are made doubly difficult by the dual nature of the program—College Credit and Technical Institute. Misunderstandings between these programs in some cases have apparently worked against the best interest of the entire Extension. There is, of course, no fundamental conflict between the two sets of objectives as they almost perfectly complement each other. But artificial barriers may arise and even be magnified into important obstacles to progress, if certain pitfalls are not avoided.

In a few cases there may have been a feeling between these two groups that there is a difference in prestige, a difference in the fundamental worth and soundness of the two programs. Such a conception, of course, disappears when a sound general philosophy of Technical Education as a whole is developed. The feeling that one program can grow only at the expense of disregarding or sabotaging the other is not well founded. To avoid and to eliminate this feeling become the direct responsibility of teaching and administrative staff. Inasmuch as the objectives are so different, the instructional problems and procedures must differ widely. This difference automatically eliminates much overlapping of staff functions—teaching in both programs. But where overlapping instruction is possible, without detriment to either program, it is heartily advocated for its unifying influence. There has existed an attitude on the part of some that one program is to grow and develop—the other to deteriorate to extinction. This attitude, while not based on sound fact, is deplorable in the effect it produces in disrupting proper coordination and cooperation and in undermining staff morale.

Cooperative Teamwork

A University teaching staff is not like unto a group of day laborers who do their cut-out work, perform the bidding of the boss, draw their pay, and go home. They are high-calibre men and women who think as they work, who are fully capable and qualified to contribute the fruits of their thought to the betterment of the school, if given an opportunity to do so. For administrative officers to ignore this in thought or deed, intentionally or not, is to throw away a tremendous asset of the school. For the administration alone, at any level, to set up any unique Extension policy and "spring" it in "edict" fashion on the staff is a most unwise procedure. The average staff member is fully capable of giving very sound consideration and counsel on all problems intimately associated with the Extension's progress, and if his whole-hearted cooperation is to be secured, opportunity for this must be provided and major policies projected only after a majority of the staff has become convinced of the soundness of the change and has been enlisted whole-heartedly in its support.

Here, as in so many other of our American institutions, the ultimately greatest dividends come only as the result of cooperative teamwork.

Some Thoughts on the Purpose of a College Education*

By ROBERT S. ROWE

Associate Professor of Civil Engineering, Princeton University

Have you ever stopped to ask yourself the purpose of a college education? Is it to obtain knowledge? Is it to insure a job? Or is it to guarantee wealth and success?

Have no illusions. Of the vast amount of knowledge available, a student is exposed to a very small amount, and two years after graduation he has forgotten much of that. An education is an opportunity and does not guarantee anything. You get out just what you put in —no more, no less. It is true that if you have been adequately educated, you will have the tools which will enable you to compete with men from other institutions; and if you are fortunate, you may gain wealth and success. But what is an adequate education?

An adequate education depends upon three things: the understanding of fundamental concepts; the desire to seek the truth; and the ability to ask questions.

It is essential that you know the fundamental concepts which pertain to the basic subjects that interest you, and perhaps a few fundamentals pertaining to unrelated subjects. A good teacher will present the fundamental concepts. But there are relatively few good teachers. It may be that you are forced to dig the fundamentals out for yourself. Perhaps you will be inspired in such a way that digging becomes a challenge. The understanding of a few fundamentals is much more valuable than a large amount of unclassified knowledge.

One of the important aims of a college education is to teach you to seek the truth. You are taught not to accept written matter blindly, but rather to understand what you read so that you may determine what is true. It is often difficult to be truthful with yourself. If you do not know the answer to a question, you are shown that there is merit in working out the solution for yourself. You gain nothing by relying on someone else's ability. Of course, it is easier to coast downstream (let someone else do your thinking for you) than to pull up against the current (think for yourself). In one case you cover a lot of ground, but gain nothing; in the other case, you cover less ground, but profit immeasurably.

And closely related to seeking the truth is the ability to ask questions. It is not difficult to find someone to answer questions. There are many who prefer to use their instructor as a slot machine: put in the question, turn the crank, and obtain the answer. But this method does not help them one bit. The important thing is to ask questions of yourself which will lead you to the solution. What is the fundamental upon which this is based? Is this or that true? Why? Is there another way of doing this? How? . . . ad infinitum. By asking questions and thinking things out for yourself, you will obtain a better understanding of any problem.

A college education, then, is nothing more than an opportunity where each individual is entirely responsible for his own attainments. The possibilities for learning are unlimited. The synthesis depends upon the understanding of fundamental concepts, the desire to seek the truth, and the ability to ask questions.

Acknowledgments. The ideas expressed herein have been influenced by the writing of George Fillmore Swain and the teaching of Hardy Cross.

* Written at the request of a group of students.

International Conference on Engineering Education—London, January 12–17

The sessions of the International Committee on Engineering Education of the United States and Europe Council of Engineering Societies more commonly called EUSEC were the first on engineering education held in Europe. The hosts were the Institutions of Civil, Mechanical and Electrical Engineering of Great Britain.

While in North America the Colleges of Engineering have been organized for sixty years and are currently arranging their sixty-first Annual Meeting, no such unifying force has been at work in Western Europe and Great Britain.

EUSEC has had one previous conference devoted to Management, this in the Netherlands in 1951. The organization committee on Engineering Education was requested to present a review of existing patterns of engineering education and practice in each of the cooperating nations, then bring in recommendations or future cooperation between the EUSEC members in matters of engineering education and practice.

North America representation was made up of Col. L. F. Grant of Canada, Chairman of the Engineers' Council for Professional Development, Dean Thorndike Saville, Chairman of the E.C.P.D. Committee on Engineering College Accreditation, and Dean W. R. Woolrich, President of the American Society for Engineering Education. Three practicing engineers and engineering educators likewise represented the nations of Norway, Sweden, Denmark, Belgium, Netherlands, France, Switzerland, Italy and Great Britain.

The six days of sessions from January 12 to January 17 beginning daily at 10 A.M. and continuing usually to 10 P.M. ironed out many misunderstandings as to the status and education of engineers in the countries represented and there developed a greatly increased appreciation of each others problems as the meetings progressed. By the end of the sessions delegates were calling each other by their first names as if they had known each other from childhood.

The agenda for these days was divided into the following headings:

(a) The classes of educational establishments with courses leading to professional engineering qualifications, stating the number of establishments in each class.

(b) The number of students successfully completing the final examinations at the end of the courses in each of the classes in (a).

(c) The general educational requirements before a student may be admitted to a course of academic study in the classes in (a).

(d) Scope and broad extent of study in the following subjects in each of the classes in (a):
Basic Science
Applied Science
Technological Applications

(e) Method of examination and the nature of the award granted on the conclusion of the studies in each of the classes given in (a).

(f) Scope of nature of practical training and subsequent experience required for professional qualification.

Several weeks of preparation for each nation's team was given over to the preparation of papers on the history and procedures of engineering education and rec-

ognition. Preprints of these reports were available to each of the delegates prior to the convening of the conference.

Considerable time was devoted to definitions of educational and engineering terms which have widely different meanings in the countries represented. For example a "College of Technology" suggests an institution that offers a Bachelor of Science degree in North America but in Great Britain it more commonly indicates an institution giving a wide range of day and evening courses in cooperation with industry mostly on the trade school level, while in Belgium it would have a still lower level of academic rating. It is quite evident that the development of a standard international terminology for engineering education is a desirable goal to pursue.

With the annual influx of some three thousand graduate students coming into the United States for advanced work and when we recognize that a large number of these intend to take graduate level courses in engineering, then we can more fully appreciate that the Universities and Colleges of Engineering of the United States have a very great interest in the minimum standards, the quality and the philosophy of engineering education beyond the Atlantic.

We have much to give Great Britain and Western Europe from our sixty years of experience in engineering education study and analysis, but in turn we have much to learn from their many patterns of engineering education which have been especially designed to meet highly industrialized regions.

Those of us who spent the five or six days in continuous conference together at these preliminary sessions were convinced that similar biennial sessions would be of great value in raising the quality and effectiveness in engineering education in all of the eleven countries represented.

In both war and peace the professional engineer must carry on major responsibility for the industrial economics, the scientific advancement and the management accomplishment of each of the nations represented. The success of any Atlantic confederation must necessarily rely very largely on the cooperation of its scientific and engineering personnel.

The sessions concluded by recommending to EUSEC that biennially similar sessions be convened and that the next conference be held in one of the European countries September 27 to October 2, 1954 with interim working committees designated to preparing reports on those educational problems that are of special international interest and concern to professional engineers. The Proceedings of the Organization Conferences will be available within a few weeks from Great Britain.

1953 ASEE-GE Teaching Methods Seminar

For the second consecutive year the General Electric Company is joining with the American Society for Engineering Education in sponsorship of a seminar on "Teaching Methods in the Advanced Engineering Program." The 1953 seminar will be held in Schenectady, New York, from June 15–20.

The operation of the seminar will be somewhat similar to last year's as recommended by Messrs. B. R. Teare, Jr. and K. B. McEachron, Jr. in the *Journal of Engineering Education*, January 1953. The present plans will include the application of some of the newer techniques, such as the use of a creative approach to the solution of a professional type engineering problem. Below is a rough sketch of the operation of this year's seminar.

Again, each portion of the seminar will have two phases. The first is the demonstration of a teaching technique as used in the Advanced Engineering Program, and the second is the application of the technique to college teaching.

One of the major pillars of teaching philosophy in the Advanced Engineering Program is "learning by doing." The seminar therefore will teach the problem-solving method of learning, by using the method itself. Actual problems will be worked by the seminar members and as much as possible of the atmosphere between the instructor and the student as used in the Advanced Engineering Program will be maintained. Most all A.E.P. lectures have evolved toward discussion periods with active participation by all present.

The problems which will be assigned will be typical of problems encountered in the Program, but somewhat shortened to use more efficiently the time available. Most Program problems are of an analytical nature and are designed to emphasize the firm foundation of understanding of a principle involved. Each of proposed problems for the seminar will require some time for solution, with the beneficial accompanying evaluation and discussion. Combined with the actual solution, the discussion soon after submission of the results firmly implants the material covered. The seminar will include evening sessions as well as morning and afternoon.

Perhaps the largest benefit that the seminar members will receive will be through the free interplay of thoughts and ideas that flow between the participants. All members of the seminar will be housed in a single fraternity house on the campus of Union College in Schenectady. Thus housing and dining will be arranged to stimulate and maximize discussion.

Certainly not all of the Advanced Engineering Program is profitably spent in concentrated problem solution. Saturation of learning seems to occur if extra-curricular breaks are not included. The seminar members will likewise include breaks for an "entrance exam," a smoker, and a "graduation banquet." A tour of sections of the Schenectady Works and Knolls Research Laboratory in addition to conferences with engineers prominent in a given field will probably be arranged.

Staff members representing most accredited colleges (Electrical or Mechanical curricula) have been contacted and asked to submit candidates for seminar membership. On the basis of providing a geographical and curriculum-wise distribution of members, 25 individual candidates will be invited to attend.

All expenses including transportation for the members will be borne by the General Electric Company.

Any further information concerning the 1953 ASEE–GE Seminar on Teaching Methods may be obtained from the Advanced Engineering Program, General Electric Company, Schenectady 5, New York.

Discussion on "A Philosophy of Graphics"

By JOHN SCOTT CAMPBELL

Instructor in Electrical and Mechanical Engineering, California Institute of Technology

John Rule's recent paper on "A Philosophy of Graphics" should serve as a stimulus for all of us who teach this old and honorable subject. It should make us ask ourselves the question: Just what is graphics, and what can it do for the student in science and engineering toward the furtherance of his career?

There are many ways of looking at graphics. Like the blind man making a Braille examination of the elephant, it depends very much upon our viewpoint. From the standpoint of the engineering draftsman, it is a language by means of which the engineer communicates his design ideas to other engineers and to the man in the shop. A little better version of this viewpoint makes graphics the means for design itself, whereby the layout man clarifies his own original ideas by getting them down on paper. Those of us who advocate a touch of freehand drawing see graphics as a way to sharpen up the student's powers of observation, and to improve his ability to visualize in three dimensions. Descriptive geometry looms large in any graphics course both as a practical method of solution to knotty geometrical problems, and for its value in improving abstract visualization. Less emphasized now is the solution of problems by graphical construction: all the old straightedge and compass constructions that produce such pretty designs, but which also at times are very useful. And still occupying an uncertain position in graphics is the whole field of representation of data by graphs, ternary diagrams and the like, and the field of graphical calculation by function scales and nomographic charts.

Now this may seem like a large and helter-skelter collection of topics relating to graphics. What is needed, perhaps, is a unifying viewpoint to tie it all down and put the loose parts in their proper places. Professor Rule's discussion goes far toward supplying such a viewpoint. I would like to venture forth with another thought, for what it may be worth.

The activities of both scientists and engineers may be classified broadly into three phases: The collection of data; its analysis and reduction to usable form; and its application in the solution of problems. These divisions are not sharp, but rather lie upon a continuous scale. The thinking of an individual scientist or engineer ranges back and forth along this scale constantly, and, indeed, one mark of a good scientist or engineer may be the ability to be equally at home on all parts of the scale. In general, however, we may say that the scientists live mostly near the "data collection end" whereas the engineers are generally congregated at "applications."

Both must spend time in the middle, however, where the important job of reduction and interpretation is performed. Now let us inquire for a moment just what happens in this central region of our scale. A great deal of data reduction and problem solving is done by straight intuitive reasoning. But long ago it was found that the intuitive ability of the human mind has its limits, and so a system of symbols was devised for recording quantitative data, and rules developed to manipulate and transform data without the introduction of distortion, in order to present it in a more appealing and understandable way to the mind. From the viewpoint here being developed, this is mathematics. At the same time the scientists discovered that the most convenient

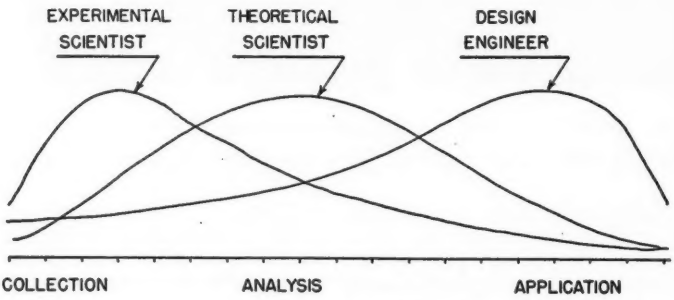

FIG. 1.

ways of measuring things did not always yield results which were easy to visualize and hold in mental contemplation. And so new concepts were invented, like energy, inductance and entropy which are not obviously present in nature to be sensed, but which seem to appeal to the mind in the sorting and comparing which makes up problem solving.

Appeal to our Senses

It is about here that graphics comes finally into this discussion. For the process of clarifying understanding logically starts with an appeal to our senses, of which the visual is most important. So I submit that graphics is, first a way of converting ideas into visual form so that they may be taken into the brain by the great main channel of communication with the outside world, the eye. To do this we employ pictorial devices to represent physical quantities: bar graphs, curves, positions on function scales and in the areas of charts, tone gradation, colors, the concept of contours of equal value and three dimensional models.

I believe that we have hardly scratched the surface of graphics, viewed in this way. For this is more than a means to an end: it goes into the most intimate processes of thought and determines the very shape and texture of the idea which we examine, rework and finally turn out as a solution. How often is our trouble caused by "not quite seeing it the right way"—and how often has the solution been unexpectedly smoothed by "A new viewpoint"? These old expressions are founded upon experience in a field which is essentially graphical—a field as old as man, and at the same time one offering exciting opportunities for new developments.

Professor Rule's remarks have opened the door to a whole new vista in graphics. A part of this view, I believe, is suggested by the foregoing brief discussion. There are many other aspects in this useful and interesting subject. I look forward to the further development of Professor Rule's philosophy of Graphics in the pages of ENGINEERING EDUCATION and other publications.

Section Meetings

Section	*Location of Meeting*	*Dates*	*Chairman of Section*
Allegheny	West Virginia University	April 17–18, 1953	C. H. Cather, West Virginia University
Illinois-Indiana	Rose Polytechnic Institute	May, 16, 1953	H. A. Moench, Rose Polytechnic Institute
*Kansas-Nebraska	Kansas State College		M. H. Barnard, University of Nebraska
Michigan	Detroit Institute of Technology	May 9, 1953	C. C. Winn, Detroit Institute of Technology
Middle Atlantic	University of Delaware	May 2, 1953	C. Bonilla, Columbia University
Missouri	Washington University	April 11, 1953	G. F. Branigan, University of Arkansas
National Capital Area	Howard University	May 9, 1953	L. K. Downing, Howard University
New England	University of Vermont	Oct. 10, 1953	E. T. Donovan, University of New Hampshire
North Midwest	Marquette University	Oct. 9–10, 1953	A. B. Drought, Marquette University
Ohio	University of Cincinnati	May 2, 1953	H. K. Justice, University of Cincinnati
Pacific Northwest	Washington State College	April 24–25, 1953	J. P. Spielman, Washington State College
Pacific Southwest	San Jose State College	Dec. 29–30, 1953	C. M. Duke, University of California at Los Angeles
Rocky Mountain	University of Colorado	April 11, 1953	C. A. Hutchinson, University of Colorado
*Southeastern	North Carolina State College		D. V. Terrell, University of Kentucky
Southwestern	University of New Mexico	April 3 & 4, 1953	M. L. Ray, University of Houston
Upper New York	Rochester Institute of Technology	October, 1953	F. E. Almstead, State University of New York

Members of the Society are welcome at all Section Meetings

*** No Date Set.**

TEACHING POSITIONS AVAILABLE

The following rules were adopted by the General Council of the ASEE:

1. The privilege of advertising for teaching positions is extended only to colleges and technical institutes which are either Active or Affiliate Institutional Members of the ASEE.

2. Advertisements must be for positions available only. No advertisements will be accepted for an individual seeking a job.

3. Advertisements should not specify salaries.

4. Advertisements must be submitted not later than the first day of the month preceding the month of issue.

5. Because of limited staff, the ASEE headquarters cannot maintain personnel files or supply detailed information about jobs. In replying to blind ads, address letters to American Society for Engineering Education, Northwestern University, Evanston, Illinois and give blind ad number.

6. Information and rates for advertising in the Journal can be received by writing ASEE Headquarters.

7. In order to conserve space and achieve uniformity, the privilege is reserved to rearrange advertisements.

BROWN UNIVERSITY HAS OPENings for Instructors and Research Assistants in the Fields of Electronics, Electrical Machinery, Experimental Stress Analysis, Mechanics of Solids, Mechanics of Fluids, Thermodynamics, Transonic and Supersonic Wind Tunnel Experimentation. Positions involve ½ time work and ¾ time study or ¾ time work and ½ time study leading toward M.S. or Ph.D. degree. Salaries for June graduates are adequate and account is taken of experience and special qualifications. Write to: D. C. Drucker, Chairman, Division of Engineering, Brown University, Providence 12, R. I.

UNIVERSITY OF CALIFORNIA, Berkeley. September, 1953. Appointments require teaching of basic courses to the field of specialization as well as advanced courses in the field. Research and development activities are expected of all staff members. *Civil Engineering:* Professor in Structural Engineering. Experience: Outstanding engineering practice, research and teaching, to qualify for directing and developing research in structural engineering and materials in addition to teaching graduate work. Associate Professors: 1 Engineering Materials, 1 Municipal Engineering. Education: Minimum, M.S. or equiv. Engineering degree. Experience: Minimum 10 years, should have considerable engineering practice or research and development experience in specialized field. Assistant Professors: 1 Soil Mechanics, 1 Structural, 1 Construction. Education: Minimum M.S. and two years research and development experience of Ph.D. Experience: Minimum 2 years including 1 year professional practice. *Mechanical Engineering:* Associate Professors: two, 1 in Heat Power Engineering and 1 in Metal Processing (resistance welding). Education: Minimum M.S. or equiv. Engineering degree and 2 years of research and development engineering experience in industry. Experience: Should have 2 to 3 years industrial experience and some teaching in engineering subjects at college level. Instructor: two, 1 Heat Power Engineering and 1 Hydraulic Structures. Education: Minimum Ph.D. degree or M.S. degree and 2 years of equiv. research and development engineering experience in industry. Experience: Minimum none, desirable 1 year part-time teaching experience in engineering laboratory courses. Apply to Dean of Engineering.

INSTRUCTOR OR ASSISTANT PROFESSOR of Civil Engineering with advanced degree, to teach Mechanics. Rank and salary dependent upon training and experience. Location, northern New York. Ap-1.

ASSISTANT PROFESSOR OF CIVIL Engineering. Major activity will be in the area of Surveying and Mapping for which a background of experience is desirable; salary open. Ap-2.

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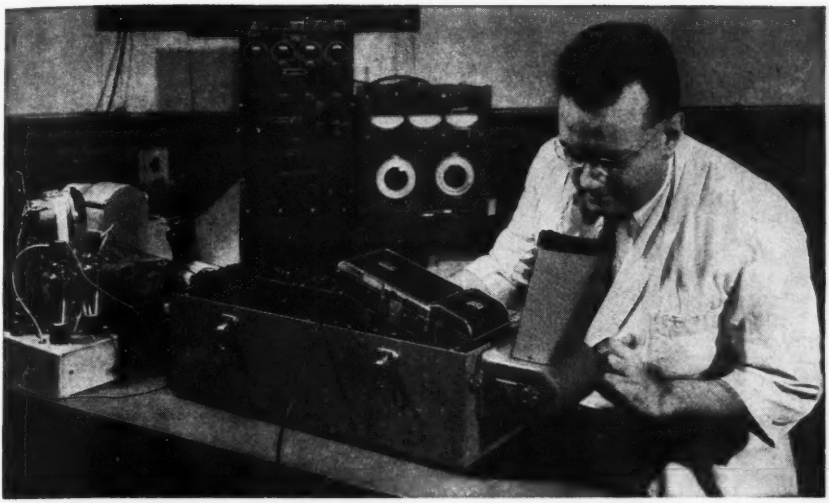

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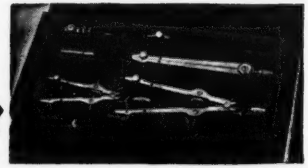

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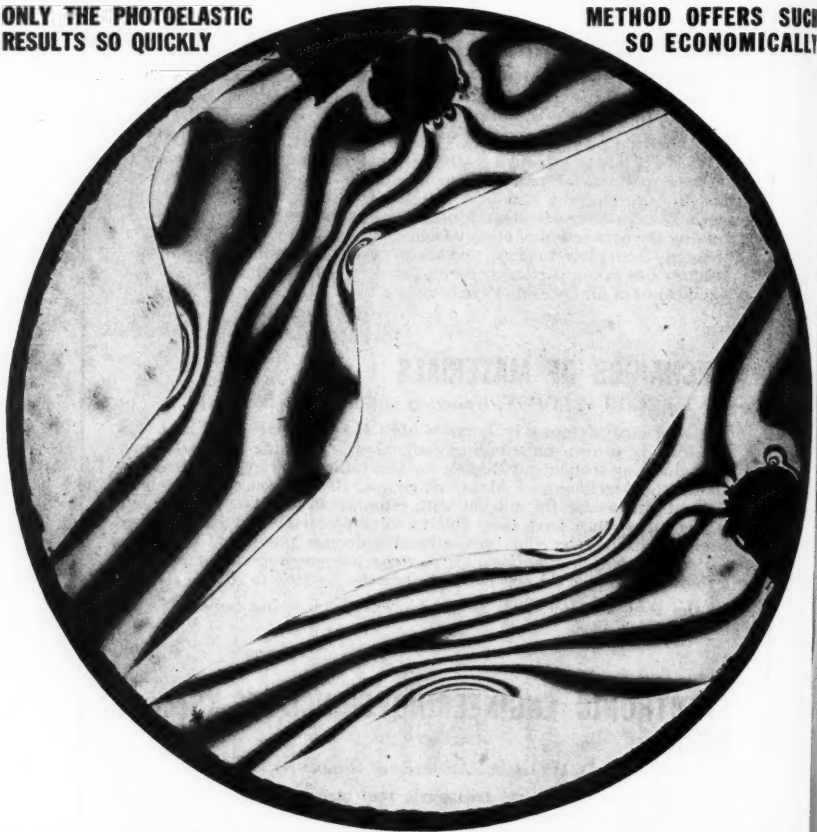

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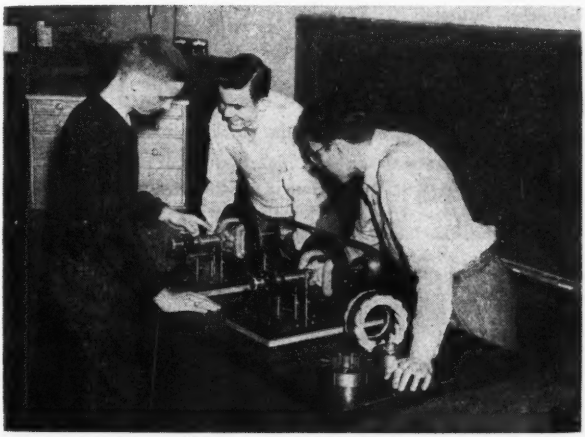

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